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Executive summary

The Working Group on Marine Habitat Mapping (WGMHM) convened in Germany from 5–8 April 2005 at the Alfred-Wagener Institute for Polar and Marine Research (AWI). The meeting was chaired by David Connor (UK) and was attended by 30 delegates from 13 countries.

International programmes

Progress in the following **international habitat mapping and classification programmes** was reviewed:

- A project by NIVA (Norway) to prepare EUNIS habitat maps for the North Sea on behalf of the European Environment Agency (EEA), in which a map to EUNIS level 3 had been prepared using available datasets including substrate type, depth, photic zone and wave exposure.
- The OSPAR priority habitat mapping programme, led by JNCC (UK), in which OSPAR Contracting Parties are submitting data on the distribution of 14 threatened habitats. Preliminary maps in a web-based mapping application were demonstrated. Peer review of the maps and data was advocated by WGMHM.
- Development of the EEA's EUNIS habitat classification, including revision of its marine section, which is available at http://eunis.eea.eu.int/habitats.jsp. A correlation of the EUNIS types to the Habitats Directive Annex I habitats and the OSPAR priority habitats has been produced by JNCC. WGMHM recommended a feedback mechanism be established to provide comment and improvement to the EUNIS system, and that further testing via mapping programmes was required.
- The proposed Interreg BALANCE project, led by DFNA (Denmark), which would, if funded, develop a broadscale map of marine landscapes for the Baltic Sea and finer scale habitat maps in four pilot areas. The Baltic MPA Life project will provide habitat maps for EC Habitats Directive sites across the eastern Baltic.
- The Interreg-funded MESH programme, which aims to provide habitat maps and associated modelled maps for the north-west Europe area, together with guidance on protocols and standards for habitat mapping.
- The Arctic Coastal Biodiversity Assessment project, under the IASC, which includes a significant coastal classification and mapping element for the circum-Arctic region.

In response to a request from HELCOM, a strategy for implementing the **development of a habitat classification framework and habitat maps for the Baltic Sea** was discussed; WGMHM recommended that this is best achieved by a) establishing an international project in the Baltic Sea Region, b) assessing existing work in producing marine landscape and broadscale habitat maps, c) compiling the necessary datasets at a Baltic Sea level in a GIS and d) validating the resultant broadscale maps with existing (or newly collected) biological sample data. WGMHM considered that the BALANCE project, if funded, would provide the best possible avenue, in the foreseeable future, for delivering HELCOM's request.

Develop a **habitat map for the North Sea** was considered in the light of other relevant initiatives, particularly the EUNIS, MarGIS and MESH projects. WGMHM recommended that the EEA should be further encouraged to continue its North Sea mapping project and that WGMHM contribute to this through the provision of further datasets and expertise.

In **comparing the various international habitat mapping methodologies**, WGMHM was able to draw up a generic set of data types that are necessary to develop broadscale habitat and marine landscape maps.

National programmes

WGMHM discussed the National Status Reports for Canada, France, Germany, Denmark, Ireland, Netherlands, USA, UK, Poland, Belgium, Finland and Portugal. Whilst there was considerable effort in habitat mapping across ICES countries, the approaches adopted differed markedly from single major country-wide programmes to more local projects to meet specific needs, and from undertaking new remote sensing survey to the use of existing data and modelling. A common theme to the work presented was a lack of confidence maps; WGMHM discussed the basis for assessing confidence in maps and advised that further effort in this area was necessary so that managers and policy makers better understand the maps they use.

Protocols and standards for habitat mapping

WGMHM developed the following working definition of the term 'habitat': a *recognizable space which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular spatial and temporal scales*; and discussed the related terms 'marine landscapes' and 'seascapes'.

In progressing work on guidelines for habitat mapping, WGMHM provided comment on a major review of techniques and standards recently completed by the MESH programme. WGMHM considered to reviews to be particularly helpful in drawing together from disparate sources the existing knowledge on a wide range of techniques, and agreed to provide further peer review as this work progressed.

The increasing importance of metadata was recognised, as part of the growing requirement for quality assured mapping data. Hence it was considered important to record the conditions and techniques under which the data were gathered. The draft suite of metadata fields, developed by the MESH project, and which covered a suite of survey/sampling techniques, were considered to form a good basis for metadata standards for mapping studies; WGMHM recommended examining standards in use in the USA and Canada.

Mapping strategies and survey techniques

In reviewing progress on intercalibration and quality control of mapping techniques, it was noted that a wide range of remote sensing calibration activities are planned for 2005. Inadequate calibration of multibeam systems could lead to poor levels of accuracy in the data and that it was therefore important to record the level of calibration in the metadata. In discussing calibration of biological data for mapping studies, it was recognised that a significant gap existed in inter-worker testing mechanisms for both species and habitat identification, especially of epibiota. Some UK-led developments were trying to address this issue.

The activities of the SGASC relating to acoustic seabed classification could not be reviewed, as their report was not yet available.

Uses of habitat mapping in a management context

In reviewing the application of and needs for habitat maps in a management, it was acknowledged that good habitat maps can: a) significantly help end users better understand ecological status and the impacts of anthropogenic activities, b) guide more effective placement of scientific measurement tools in the marine environment, c) inform, and place relevance on, the positioning of national monitoring stations, d) be used to assess environmental quality, e) be

used to develop management zoning schemes within MPA's and f) help place the impacts of disturbance into a regional or national context and consequently facilitate the assessment of the significance of potential impacts.

Relevance of habitat mapping to other aspects of marine ecosystems

The request by REGNS to provide habitat mapping data at EUNIS level 4 for the North Sea area, to contribute to the forthcoming REGNS integrated assessment of the North Sea, was addressed by requesting the EEA make available its EUNIS habitat map of the North Sea.

The development of habitat maps for the pelagic zone of the Bay of Biscay focussed on characterising water masses according to different trophic levels (e.g., phytoplankton, small fish) and correlating these to various oceanographic factors (e.g., temperature, salinity, nutrients). WGMHM acknowledged that this approach to mapping the pelagic zone, through correlating biological and physical datasets, had many similarities to mapping seabed features.

In considering ICES' future requirements from WGMHM, it was recommended that there be closer cooperation with other relevant WGs. This could be achieved through arranging joint meetings which could significantly increase the cross fertilisation of habitat mapping ideas across relevant groups and help focus future direction for a more integrated ICES effort in the field of habitat mapping.

1 Opening of meeting

The Working Group on Marine Habitat Mapping (WGMHM) convened in Germany from 5–8 April 2005 at the Alfred-Wegener Institute for Polar and Marine Research (AWI). Dr Chris Cogan opened the meeting on behalf of the AWI Director Professor Jörn Thiede.

The meeting was chaired by David Connor (UK) and hosted by Chris Cogan, with the financial support of AWI. It was attended by 30 delegates from Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Norway, Poland, Portugal, Spain, the Netherlands and the UK (Annex 1), each providing a brief introduction about themselves. Apologies were received from the following WG members: Becky Allee (USA), Dieter Boedeker (Germany), Kerstin Geitner (Denmark), Stig Helmig (Denmark), Per Sand Kristensen (Denmark), Peter Lawton (Canada), and Doris Schiedek (Germany).

1.1 Appointment of Rapporteurs

The task of preparing the report of the meeting was shared amongst participants as follows: Fiona Fitzpatrick (item 3), Els Verfaillie (item 4), Roger Coggan (item 5), Brian Todd (item 6), David Limpenny (items 7) and Neil Golding (item 8), with additional contributions from individuals who made presentations.

1.2 Terms of Reference

The Terms of Reference for the meeting were noted and are given in Annex 2. The Agenda and this report were specifically structured to address each item on the ToR.

2 Adoption of Agenda

The previously distributed draft Agenda for the meeting was discussed, adding several additional national status reports and presentations. The adopted Agenda is given in Annex 3.

3 International programmes

3.1 Progress in international mapping programmes

Review progress of international mapping programmes (e.g., MESH, EEA, Baltic, ICES) (ToR d)

3.1.1 Development of EUNIS marine habitat maps for the North Sea

Kjell Magnus Norderhaug (NIVA, Norway) presented work undertaken jointly with Frithjof Moy concerning a programme to prepare EUNIS habitat maps for the North Sea on behalf of the European Environment Agency (EEA).

The principal aim of this area of EEA activity is to identify habitat distributions at a European level and thus permit national authorities to place and assess their habitats in a European context. The project has collected and collated relevant data in a GIS environment and constructed a marine habitat test map for the North Sea according to EUNIS level 3 habitat types. The first steps of the project were to collate an overview of existing data relevant to EUNIS habitat mapping, identifying in particular the need for datasets for the coast, bathymetry, substrate and wave exposure. Data were acquired following a questionnaire to stakeholders and searches of EIONET (www.eionet.eu.int) and other potential sources, leading to datasets at 500m pixel resolution for the North Sea area. There were several challenges to the project: the input data

are at different scales; few data from shallow water areas were identified; detailed bathymetry is not readily available because of national security issues, data are presented in different formats and matching different data types is time consuming. Also it was a challenge to overcome variation in data density and there was a mismatch between terrestrial and marine boundaries, which can result in a gap in data coverage in coastal regions. The project has now produced a seamless map of the North Sea at EUNIS level 3.

Discussion

This presentation was well received by WGMHM in the context of the requirements of REGNS (ToR l) to provide a benthic habitat map of the North Sea. This project has produced several data layers, including layers on bathymetry, wave exposure, secchi depth and substrate. With respect to the benefits of having a continuous map of the North Sea, the following points were highlighted:

1. Metadata followed the EEA standards.
2. The secchi disc depths represent measurements made over a period of time, and from a variety of cruises. WGMHM advised that, as these measurements have been taken sporadically throughout the year, they do not reflect expected seasonal variations.

3.1.2 The OSPAR priority habitat mapping programme

David Connor (JNCC, UK) reported on UK-led work on habitat classification and mapping undertaken in support of OSPAR's Biodiversity Committee (BDC) activities on habitats that are threatened or declining; ecological quality objectives (EcoQOs) in the North Sea; marine protected areas; quality status reporting and the Joint Assessment and Monitoring Programme (JAMP). A habitat classification for the north-east Atlantic had been developed through a joint programme with the EEA and ICES, leading to a Biodiversity Committee-approved working classification for the north-east Atlantic in 2004.

A workshop in October 2002 developed proposals on how to take forward habitat mapping across the OSPAR area; these were considered by BDC in February 2003. Two aspects were identified: (i) a need to carry out mapping of priority habitats across the entire OSPAR area and (ii) development of a holistic habitat map of smaller areas, for example the North Sea. BDC agreed to proceed with the priority mapping proposal, involving 14 priority habitats and an agreed timescale for the project. Contracting Parties were asked to submit data on habitats within their waters. To date, nine of the 12 Contracting Parties had supplied data. The data were presented as: (i) a series of paper maps with data aggregated to 50x50 km grid squares and (ii) web-based GIS, which showed data as point samples (except where it was necessary to restrict access levels, for example a 10 km grid limit on oyster bed data). The web-based application awaits OSPAR approval (expected in June 2005) before it can be publicly released. In summary, the project provides simple point distribution maps for each habitat type across the OSPAR area. The maps need to be treated with some caution, as the data submissions are still patchy; nevertheless they represent a useful advance in knowledge and demonstrate a multinational biodiversity collection programme.

Discussion

WGMHM discussed the possibility of expanding the point data into polygon-based maps. As this was not the original intention of the project, it was not within its present scope; however once the MESH project is underway, it was anticipated that polygon data from this programme could be integrated. WGMHM welcomed the initiative and recommended that the maps and data on the web site be reviewed annually to assess their completeness.

3.1.3 Developments with the EEA's EUNIS habitat classification

David Connor (JNCC, UK) gave an update on recent developments with the EEA's EUNIS habitat classification. Historically, the EUNIS classification had developed following a series of earlier European classifications (CORINE 1989, 1991; Palaearctic 1993, 1996), which were incompletely developed for marine habitats. Development of the EUNIS classification started in 1996, intending to be developed through the four major sea conventions: Mediterranean, Black Sea, North East Atlantic and Baltic). It was initially based largely on the 1997 BioMar MNCR classification for Britain and Ireland. The latest version (October 2004; http://eunis.eea.eu.int/habitats.jsp) has incorporated the 2004 OSPAR classification, the 2004 revision of the BioMar classification (www.jncc.gov.uk/MarineHabitatClassification) and additional improvements to the Baltic Sea classification.

A table has now been produced which maps the close correlation between EUNIS and Bio-Mar, together with correlations to Habitats Directive Annex I habitats and OSPAR priority habitats. This table will be available shortly at www.jncc.gov.uk. Further development of EUNIS is being taken forward in a 4-year programme coordinated by the European Topic Centre on Biodiversity (ETC/BD). The JNCC have been tasked to improve the Baltic and Atlantic aspects and is keen to see the classification properly validated with observational data to test the practical application of the system. It is particularly important to assess the use of remotely-sensed habitats in relation to the broader habitat classes; this will be addressed in the MESH project. It is expected that the classification will be further revised, particularly with respect to the offshore, deeper water areas.

Discussion

WGMHM inquired whether there was a feedback/consultation mechanism for individuals to provide comment on the classification, and to propose new habitat types. Several members advised that further habitat types were needed (e.g., from the French REBENT project). At the moment such a route does not exist and feedback is expected via established projects, such as MESH. David Connor was tasked to consider whether a feedback mechanism could be provided by the ETC/BD.

The use of specific boundaries (e.g., depth contours) as a basis for defining habitat types was raised. It was recognised that, in its present state, the EUNIS classification does not yet sufficiently reflect the physical and biological processes governing marine habitats, but often more simply reports on what is found. There is a need to improve the understanding of the underlying processes and to reflect this in the structure and definitions of the classification. David Connor indicated that the construction of the UK classification had sought to reflect such processes and drivers as far as were possible, based on a detailed understanding of the relationship between the physical drivers and the biota. However it was acknowledged that further work was needed to move some areas of the classification from a more descriptive basis to a more knowledge-based classification. This will develop with time as our understanding of the marine environment improves. It was suggested that a successful classification system would effectively encompass the functional and process aspects of marine habitats.

WGMHM considered that the EUNIS classification still required significant validation and that this should be encouraged through ongoing and forthcoming habitat mapping programmes; this would enable its further improvement particularly in areas away from UK waters and in relation to remote-sensed mapping data.

WGMHM recommends that the EEA and European Topic Centre for Nature Protection and Biodiversity (ETC/NPB, Paris) continue its work in developing the EUNIS habitat classification to include a more diverse range of habitats found within the Baltic Sea and the Atlantic Ocean. This task should be taken forward by a collaborative international effort rather than by

a single institution or country. In particular, existing national marine habitat classification systems in the Baltic Sea should be reviewed in more detail and used to improve the EUNIS classification, especially the levels including communities (levels 5, 6). There should be a formal feedback mechanism for comments on the current classification, and the classification needs to be validated with field data and mapping studies.

3.1.4 Baltic Sea Region

3.1.4.1 The proposed BALANCE project

Johnny Reker (DFNA, Denmark) outlined a proposal for a new project for the Baltic Sea: BALANCE (BALtic SeA management – Nature Conservation and sustainable development of the Ecosystem through spatial planning) which was submitted in March 2005 for Interreg IIIB funding. The project was in part inspired by MESH, the Irish Sea Pilot project and presentations at WGMHM 2004. It involves 20 partners and 10 countries including Norway. If funded the project will start in July 2005 and finish January 2008 with a proposed budget of €4.5m.

BALANCE aims to focus on developing and using marine landscape and habitat maps in spatial planning and management of Baltic Sea areas. It will cover the Baltic Sea, Kattegat and Skagerrak, with special focus on four representative pilot areas:

- Northern Kattegat
- Bornholm Deep
- Åbo–Åland-Stockholm
- Gulf of Riga

The aim of BALANCE is to provide the Baltic Sea Region (BSR) with marine spatial planning tools. This will be achieved through the development of a management template, based on spatial planning, to promote informed management decisions. The project's scope is highlighted by the work packages:

- WP1: to collate, intercalibrate and validate cross-sectoral and transnational data in order to provide a cost-effective use of existing data.
- WP2: to characterize marine landscapes and their distribution in the BSR. Using existing data and through the development of predictive models, holistic habitat maps will be produced for four transnational pilot areas. The maps will include benthic habitats, essential fish habitats and pelagic habitats.
- WP3: use these maps to evaluate the ecological coherence of the Baltic network of marine protected areas (MPAs), to develop the "blue corridors" concept and promote its use.
- WP4: use the habitat maps, the MPA evaluation and stakeholder involvement to develop a regional zoning approach in order to illustrate the value of marine spatial planning.
- WP5: disseminate the results through appropriate media defined by the target audiences.

The BALANCE legacy is intended to be a transnational marine management template and increased public awareness, which can assist stakeholders in planning and implementing effective management solutions for sustainable use and protection of the valuable marine landscapes and unique natural heritage of the Baltic Sea. BALANCE thus aims to provide a transnational solution to a transnational problem.

Discussion

WGMHM supports this challenging and ambitious project and considered the emphasis on the three different habitat elements (benthic, essential fish and pelagic) represented a sound ap-

proach. It was felt that BALANCE would make a valuable contribution to the HELCOM request (see ToR a).

3.1.4.2 Baltic Sea Regional Project (BSRP)

Eugeniuz Andrulewicz, representing the Baltic Sea Research Project (BSRP) and as Chair of the ICES Study Group on Baltic Sea Ecosystem Health Issues (SGEH), provided a brief update on BSRP. The project, which started in 2004, addresses problems such as eutrophication and hazardous substances. Unfortunately the marine habitat investigations will not be financed until 2006. Presently BSRP receives financial support from each of the eastern Baltic countries to improve standards, through the use of new equipment and establishing sea-going projects. A work plan has been designed and in the first year (2005), financial support has been offered to scientists to attend marine habitat mapping meetings. One representative (from Poland) attended the WGMHM 2005 meeting. WGMHM strongly encourages the five eastern Baltic countries to establish suitable representatives and become actively involved in WGMHM.

3.1.4.3 Baltic MPA Life Project

Jan Ekebom (Metsähallitus, Finland) described this project which, if approved, will start in August 2005 and last for 48 months. The project will be implemented in Latvia, Estonia, Lithuania, (and possibly Russia) and has 19 partners from Estonia, Latvia, Lithuania, Russia and Finland. The project has an intended budget of €3.2m and intends to tackle the following:

- Inventories of marine species and habitats according to the EC Habitats and Birds Directives (birds, mammals, fish, benthic habitats); completion of Natura 2000 data sheets; where necessary, delineation or adjustment of borders of marine SPAs or pSACs and designations of new sites.
- Assessment of the impact of fishery by-catch, construction and dumping activities, disturbance and pollution on target species and habitats.
- Preparation of management plans for selected sites and general recommendations for protection and management of marine Natura 2000 sites.Pilot management activity: testing and promotion of alternative fishing methods and gear in order to reduce by-catch of birds and mammals of Community Interest; facilitation of a network of fishermen and nature conservationists.
- Training for project teams; activities to raise the capacity of stakeholders to implement Natura 2000 and to increase stakeholders' and public awareness (workshops, media work, public events); exchange of experience on European level (e.g., with other LIFE projects).

Further information on the project is available from heidrun.fammler@bef.lv and www.bef.lv.

3.1.5 Progress with the Interreg MESH programme (Mapping European Seabed Habitats)

David Connor (JNCC, UK) provided an outline of the MESH programme and highlighted some early progress of the project. MESH is an Interreg IIIB initiative comprising twelve partners across north-west Europe. It commenced in May 2004, is scheduled to last 3 years and represents a €8m investment. The geographical scope of the project includes the combined extended EEZ areas of Ireland, UK, Netherlands, Belgium and northern France. The aims of the project will be achieved through six actions, which are briefly described below:

- Action 1 - Generating habitat maps for north-west Europe

  Led by the JNCC, the MESH partners aim to compile a metadata catalogue of seabed habitat mapping studies and to collating available habitat maps across north-west Europe.

Key tasks to deliver this work include: defining a metadata standard; collating existing maps of seabed habitats; developing a simple confidence rating system for habitat maps; and developing presentation standards for GIS-based habitat maps. The final output will be a web-based interactive GIS presenting harmonized habitat maps for the north-west Europe area and allowing users to query underlying attribute data and metadata. The mapping data will be harmonized according to (i) the EEA's EUNIS system, (ii) the EC Habitats Directive Annex I types and (iii) OSPAR priority habitats. MESH partners are currently assimilating the patchwork of existing data, and populating the metadata catalogue which is available at www.searchMESH.net. Tools to translate existing maps from their original classification to the standard schemes are being developed.

- Action 2 − Develop standards and protocols for marine habitat mapping

In order to establish a consistent approach to future mapping programmes and facilitate data exchange and aggregation, the MESH partnership are developing a set of agreed protocols and standards for future seabed habitat mapping endeavours, based wherever possible on existing established standards. CEFAS (UK) and IFREMER (France) are action leaders, focussing on the deeper offshore regions and intertidal/shallow subtidal habitats, respectively. Standards apply to data and ensure quality assurance of data, common terminology and formats, and compatibility of data between different techniques and technologies. Protocols apply to methods and ensure consistency in survey methodology, consistency in data interpretation, and common methods for extrapolation, interpolation and aggregation of data across spatial scales. An initial '*Review of standards and protocols for seabed habitat mapping'* has now been compiled[1] which discusses the capabilities and performance of existing techniques and technologies and identifies areas where further development is required. This review is further considered under agenda item 5.

- Action 3 – Testing the protocols and standards

It is intended that the proposed standards and protocols are tested in a series of field trials to ensure they are robust and repeatable. This iterative process will be achieved in two ways: (i) new local or regional surveys designed to test the applicability of the improved standards and protocols via targeted data collection, data processing and interpretation projects aiming to cover a range of habitat types and geographical areas and, (ii) further establishing the relationship between infaunal and epibiota communities through field sampling of both elements for a wide range of sediment habitats and examining existing data if available.

- Action 4 – Modelling

The existing marine data set for north-west Europe is expected to be variable in quality and patchy in its coverage. To infill the gaps, habitat models will be developed. Lead by the University of Gent (Belgium) and Ifremer (France), the action will develop methods and tools to predict the occurrence of habitats and to produce probability maps on their distribution, primarily based on the relationship between the main environmental factors and the distribution of selected biological communities. Development of predictive models will contribute to a better understanding of the factors and processes responsible for structuring the distribution and composition of marine habitats and their associated biological communities. The Action is divided into six stages: (i) defining key environmental factors and processes structuring marine communities; (ii) identification of the most efficient technique(s) for habitat modelling; (iii) development of a habitat prediction model; (iv) development of a methodology; (v) deriving a method to show 'confidence' and; (vi)

1 www.searchmesh.net/Default.aspx?page=1443

develop a computer model which provides a 'best fit' for new biological sample data to pre-defined habitat types.

- Action 5 – Practical applications of mapping for spatial planning and management

MESH will demonstrate, through, (i) case histories on applications of habitat mapping studies and (ii) member state workshops, the political, economic and environmental value of marine habitat maps for regional/spatial planning for sustainable marine resource management in the north-west Europe area. These workshops will help gather end-user feedback on marine habitat mapping needs and formats (e.g., type of data, scale, paper versus electronic, *etc*.). This information will contribute to the development of a follow-on strategy after the end of the MESH project.

- Action 6 – Communicating results

A key part of the MESH project is to develop an effective dissemination and communication strategy with relevant stakeholders, from both the habitat mapping practitioner community and the end-user community (managers, planners, policy makers). It is the responsibility of all partners to communicate and disseminate with stakeholders in their country and within their areas of responsibility and engender feedback on user requirements; encourage input of data and information; comment on project products; gain greater use of habitat maps; help build network of data suppliers and users; and facilitate relevant links to other initiatives. Throughout the life of the project, the outputs, including the searchable metadata catalogue of mapping studies, protocols, reports on case studies and conference proceedings and interactive, user-customisable habitat maps will be delivered through the website (www.searchMESH.net). An international conference will be organised in 2007 to present the results of the MESH project to the wider marine management community.

Discussion

Further information on the nature of the modelling part of the project was sought, including the scales to be addressed. It was clarified that the project aims to define all the variables necessary to predict a given habitat, for example, depth, bottom type, exposure to wave action (modelled or measured), whether tidal or subtidal, and rules governing their presence. These variables will be assessed to predict the potential distribution of a habitat type, which will then be validated with field data. The modelling will be applied to habitat types at a range of scales.

3.1.6 IASC working group for Arctic Coastal Biodiversity Assessment (ACBio)

Christopher Cogan (AWI, Germany) outlined a new International Arctic Science Committee (IASC) project titled Arctic Coastal Biodiversity Assessment (ACBio). Key elements of the science plan included coastal classification and mapping for the circum-Arctic, biodiversity assessment, coastal biological community mapping, scenario building, and methodology export to other coastal areas. The role of supporting scientific theory for each element was emphasized, and a series of representative input data and final applications was presented. Working definitions for the term “habitat” were discussed, pointing out how slightly different goals for marine habitat mapping have tended to blur critical vocabulary definitions. The presentations concluded with a note on the importance of validation studies for habitat mapping and biodiversity analysis, and it was noted that the ACBio project is actively seeking partners in Arctic countries to collaborate on funding proposals.

Discussion

There was discussion on the differences between habitat mapping and biodiversity assessment. ACBio is classified as a Biodiversity Programme, because its primary focus extends the use of classification systems into biodiversity assessment and ecosystem management.

3.2 Development of a habitat classification framework and habitat maps for the Baltic Sea

Discuss and propose a strategy for implementing the development of a habitat classification framework and habitat maps for the Baltic Sea [HELCOM 2004] (ToR a)

HELCOM (HELCOM HABITAT) in May 2004 had requested ICES to include the Baltic Sea in a marine habitat classification and mapping initiative. ICES responded to this request by including ToR a in the WGMHM 2005 meeting.

To respond to this request from HELCOM, a sub-group was established to discuss and further develop proposals on how a habitat classification system and habitat maps might be further developed. The conclusions of the sub-group are presented in Annex 4. WGMHM concluded the following:

The idea of making a first draft marine landscape map for the Baltic Sea Region (BSR) at the WGMHM meeting was, despite good intentions, not achievable due to the limited number of participants from the BSR and the lack of access to relevant datasets. A similar task to develop a habitat map for the North Sea (see section 3.3) had raised similar issues about data availability and also acknowledged that such tasks required considerably more time than was available at WGMHM meetings.

However WGMHM was able to draw from its experiences and expertise to outline how such a map might be produced. In particular, this work needed to build upon that described in sections 3.1.4 (Baltic Sea Region) and 3.3 (North Sea), as well as approaches described in the National Status Reports (section 4). The proposed way forward is best considered in relation to technical issues about data requirements and mapping approaches and with regard to organisational aspects, including ongoing activities, the need for transnational working and resource requirements.

The following projects are considered to provide useful examples of how the Baltic Sea region could address its goals:

a) The Irish Sea Pilot (www.jncc.gov.uk/irishseapilot)
b) The Canadian Nova Scotia projects (Roff *et al*., 2003[2])
c) The Interreg MESH project for north-west Europe (www.searchmesh.net)
d) The EEA's EUNIS mapping project in the North Sea (by NIVA, Norway) (see section 3.1)
e) The Baltic Sea Regional Project (BSRP)

2 Roff, J. C., Taylor, M.E. and Laughren, J. 2003. Geophysical approaches to the classification, delineation and monitoring of marine habitats and their communities. Aquatic Conservation: Marine and Freshwater Ecosystems, 13: 77–90.

The following planned projects in the Baltic Sea include attempts to compile marine landscape and/or habitat maps:

a) The BALANCE project (funding applied for in the Interreg IIIB programme; decision expected in June 2005)

b) National or sub-national inventory programmes, e.g., VELMU in Finland (currently in its pilot phase).

WGMHM recommends that the HELCOM request is best achieved by:

1) Establishing an international project in the Baltic Sea Region which will provide the necessary expertise, transnational co-operation and resources to deliver the goals set by HELCOM. Existing national efforts, in themselves, are considered insufficient to deliver maps at the scale required and will lead to data incompatibility issues between countries.

2) Assessing existing work in producing marine landscape and broadscale habitat maps and how these might be applied to the particular conditions (environmental, data availability) of the Baltic Sea. This would require a review of the existing literature, a description of how these maps can be developed and an assessment of the advantages and disadvantages of such maps. In addition, the experiences from ongoing or planned projects that aim to produce similar maps (such as outlined in this report) should be used to refine the most useful approaches, protocols, datasets and technical methods. Data quality issues (including the production of confidence maps) should be given particular attention.

3) Compiling the necessary datasets at a Baltic Sea level in a GIS. The types of data needed are outlined in Annex 5; particular attention should be given to data compatibility issues across national boundaries and to data exchange formats which will facilitate map development and future updating of the maps.

4) Validating the resultant broadscale maps with existing (or newly collected) biological sample data (such as might be available within national inventories and other benthic survey programmes). Such detailed community-level data should also be used to enhance the lower levels of the current EUNIS classification and, together with the broadscale maps, used to propose further improvements to EUNIS for the Baltic Sea region.

5) The approach used and any draft maps should be sent for international peer review, including to future WGMHM meetings.

WGMHM considered that the BALANCE project, if funded, would provide the best possible avenue, in the foreseeable future, for delivering HELCOM's request for a Baltic Sea map, as the project encompassed the relevant aims, would provide substantial resources and would have the necessary collaborative approach across the Baltic Sea Region.

3.3 Development a benthic/pelagic habitat map for the North Sea

Develop a benthic/pelagic habitat map for the North Sea, to EUNIS level 4 or similar, based on data sources compiled or made available to the Working Group and compiled into a GIS, and to assess future data requirements and issues arising from the process (ToR b)

WGMHM 2003 had recommended that the WG generate a prototype habitat map of the North Sea, as a practical means of using the available expertise within WGMHM, to raise issues about the habitat mapping process that could be further discussed, and to provide information of assistance to other ICES working groups. This work was further developed during 2004 and led to the 2005 ToR b as noted above. Prior to the meeting, working group members had initiated a compilation of datasets that were considered useful to start producing a suitable map.

Taking into account the outcomes of project for the EEA (see Section 3.1.1), which presented to the meeting a broad-scale map of the North Sea according to the EUNIS classification sys-

tem, a sub-group led by Brian Todd (Canada) and David Limpenny (UK) was established to further discuss and develop this ToR. The sub-group was asked to particularly note the request from REGNS to supply habitat mapping data for the North Sea (ToR l). It also took account of presentations made on National Status Reports (section 4), in particular, the presentation on habitat maps for the German EEZ (MarGIS) and other parts of the North Sea, and the ongoing activities within the MESH project. In an iterative process during the meeting the subgroup arrived at its report which is given in Annex 6.

WGMHM acknowledged the very significant progress already made in producing habitat maps for the North Sea in the EEA and MarGIS projects, each based on extensive data collation and interpretation programmes requiring several person years effort. WGMHM concluded that these projects offered the most advanced habitat maps for the North Sea at the current time and that, as such, the WG could not realistically improve on them within the time and resources available during the meeting. As both projects were not fully completed and the maps await formal publication, it had not been possible to fully examine the nature of the underlying data and the methodology for producing the maps. It was considered that these should be assessed to explore whether further improvements could be made either in the quality of the maps or the level of detail they were able to offer, particularly as WGMHM members had been able to identify some additional datasets that would be useful in such a process.

WGMHM therefore recommended that the EEA should be further encouraged to continue the North Sea mapping project and that it would be willing to cooperate through the provision of further datasets and collaboration of expertise in the development of such maps. In addition the further involvement of the MarGIS project was considered helpful, as it had both useful data and analyses processes, albeit for a smaller geographical area.

It is expected that a decision to continue the North Sea mapping project will be made by the EEA in May 2005. WGMHM offered support for continuing the project, via letter to the EEA from the WGMHM Chair.

Should the EEA not approve further funding of the North Sea mapping project, then WGMHM recommended that alternative funding should be sought immediately to take forward the work in a collaborative way. It would be particularly important to focus on the North Sea areas not already being addressed by the MESH project (*i.e.* the eastern North Sea). One suggestion is that a pro forma proposal could be constructed and circulated to potential partners in the relevant countries to facilitate the funding process.

3.4 Comparison of international habitat mapping methodologies

Compare international habitat mapping methodologies, and work towards a best practice approach (ToR c)

During the course of the meeting, a wide variety of approaches to mapping was demonstrated and others suggested in projects which wait funding. It was apparent that each project had its merits and that each was tailored to suit the particular needs of the region concerned, the availability of suitable data, resources and time. As the approaches by several significant projects were not yet fully documented (e.g., the EEA EUNIS project, MarGIS and MESH), it was not possible to undertake a detailed review of the different approaches. However, it was thought useful to examine the data sets that were considered necessary or helpful in undertaking mapping projects across large sea areas. To this end, a list of data types developed by the Baltic Sea sub-group was further examined and improved, to arrive at a generic list of data sets pertinent to developing habitat maps (both benthic and pelagic). This is presented at Annex 5. Once the projects described above were published, it would be possible to better assess their merits and recommend a best practice approach.

4 National programmes

4.1 Review of National Status Reports on habitat mapping activity

Present and review National Status Reports on habitat mapping activity during the preceding year according to the standard reporting format (ToR e)

WGMHM discussed the National Status Reports after presentations from national representatives in the Working Group. Annex 7 provides a compilation of the National Status Reports submitted to the meeting, according to the standard format agreed at WGMHM 2002.

4.2 Canada

Brian Todd (Geological Survey of Canada) described how habitat mapping is being undertaken in Canada's three oceans: the Pacific, the Arctic and the Atlantic. The Geological Survey of Canada (GSC) is undertaking benthic habitat mapping whilst Fisheries and Oceans Canada is undertaking Essential Fish Habitat mapping, with input from the GSC.

The Geoscience for Oceans Management programme (within the GSC) is the framework within which the benthic habitat mapping is taking place. Phase 1 of the GOM programme, from 2003–2006, includes mapping in the Georgia Basin and Queen Charlotte Basin (Pacific Ocean), the Mackenzie Delta in the Beaufort Sea (Arctic Ocean), and on the Scotian Shelf and Gulf of Maine (Atlantic Ocean).

Maps at scales of 1:50 000 and 1:250 000 will be produced. A map series is composed of four sheets: topography, backscatter strength, surficial geology and benthic habitat.

Phase 2 of the GOM programme will run from 2006–2010. Although not all planning details have been finalized, habitat mapping is expected to be undertaken on the Juan de Fuca plate (Pacific Ocean), the Arctic Ocean and in southern Newfoundland and the Bay of Fundy (Atlantic Ocean). Selection of areas to be mapped is based on the ocean management requirements of stakeholders including government, industry and other stakeholders. More information on GOM projects is available at http://gom.nrcan.gc.ca.

4.3 France

Brigitte Guillaumont (IFREMER) presented mapping activities underway in France:

i) The French Hydrographic Office (SHOM) developed digital depth contour products in 2002. Sixteen sedimentological and bed-form dynamic maps covering the coastal region and based on acoustic surveys and ground truthing and have been published since 1994 at 1:50,000 scale. Digital products are now available and five new maps will be published in 2005.

ii) IFREMER, in association with different partners (universities, marine stations) in the national project REBENT (since 2001) and the Interreg project MESH (since 2004) have developed different activities:

- A review based on existing datasets, with production of different digital products:
- Gridded bathymetry (one low resolution grid covering most of the Interreg north-west Europe area, one medium resolution grid restricted to the French territorial seas within this area)
- Digital maps for seabed type (coarse and medium scale) of Interreg north-west Europe area with a harmonised typology
- Holistic habitat maps: the main parts of the Channel and the Atlantic Coast are now covered by coarse and medium-scale maps, at least out from the 10

metre depth contour. The classification used is local, correspondence to EUNIS types is underway but new categories are needed.

- Distribution maps of priority habitats have been produced for *Zostera* beds and maerl beds around Brittany and partly around Normandy.
- Habitat mapping activities have been developed since 2003, mainly around Brittany in the tidal area and subtidal area up to 30 metres depth. The technologies used are Multibeam, sidescan sonar, AGDS, underwater video, satellite imagery, airborne imagery, Lidar and ground truthing. Four tidal and four subtidal sites are being studied, seven Lidar digital terrain models (DTMs), three digital sedimentological maps and six vegetation cover grids have been produced; detailed holistic habitat maps and biological data sets will be produced in 2005−2006.

iii) IFREMER is also developing predictive habitat modelling. In the MESH project, predictive modelling mainly concerns hard substratum (fucoid algal cover and kelp). In the Interreg CHARM project fish habitat maps have been produced for many species in the eastern Channel.

iv) Others. Habitat mapping activities have been conducted mainly around Brittany. They mainly concern Natura 2000 sites. Three digital holistic habitat maps have been produced under the direction of the Ministry of the Environment (MEDD/DIREN Bretagne).

v) A national research sampling programme (PNEC) is being undertaken by universities and the National Museum (MNHN) in Baie du Mont Saint-Michel. These data will be used jointly with aerial photography and Lidar for habitat mapping.

4.4 Germany

Kerstin Jerosch (Alfred–Wegener–Institute) described the MarGIS project (Marine Geo-Information System for Visualisation and Typology of Marine Geodata) which is funded by BMBF (Federal Ministry of Education and Research) and DFG (German Research Foundation) and will be completed later in 2005.

MarGIS aims to characterise distinct provinces at the seafloor through the combination of geological, biological and chemical properties using GIS, geostatistical and multivariate statistical techniques. Such a typological approach supports, besides scientific needs, management decisions related to upcoming economic uses of the seafloor.

The project includes the acquisition of existing data, the evaluation and integration of the data into a marine data model, its processing with geo-statistical methods, the Web-based supply of the maps via ESRI's ArcIMS9.0 application and its analysis with multivariate statistical methods.

Compared to the volume of existing data, very few concepts had been developed for the efficient integration of various inhomogeneous data sets into existing database structures and the distribution of such data and thematic maps to the research community and general public. MarGIS intended to fulfil these requirements through generation of a marine Geo-Information-System (GIS) which would encompass single information layers in formats as diverse as vector maps, field data and maps gained by acoustic techniques such as echo sounding systems for bathymetry, sediment properties or fisheries.

An abundance of inhomogeneous data sets for various parameters were available to the project, presenting problems in their integration into the data model: different data providers handled data records in different ways and there were large differences in the quality of the metadata (particularly with GIS data). To integrate different data formats (e.g., analogue surface maps, raster maps, acoustic data, point data, iso-lines) a geodatabase system (ArcSDE9.0) was used. Due to the quantity of the data to be handled, it was decided to provide a Digital Atlas

of the North Sea (DENS) that served as an overview. This currently contains over 50 maps and acts as guidance for the ArcIMS use within MarGIS.

The combination of single information layers as contour maps, field data or bathymetric models provides a frame of reference for the calculation of spatial budgets and consideration of benthic habitats. Also after a multivariate statistical analysis to identify habitat types, GIS techniques help, as blending, to interpret the results.

The data processing to produce benthic maps was described by Roland Pesch (University of Vechta) in a presentation entitled: Marine habitat mapping within the German EEZ by means of GIS, geostatistical methods and classification and regression trees (Annex 8). Point sample data on benthic species had been analysed (by Rachor and Nehmer, 2003[3]) to describe different communities within the German EEZ. The methods to make habitat maps are classification and regression trees: a set of predictor variables (salinity, temperature, silicate, dissolved oxygen, nutrients, water depth, sediments) was used to define a suite of predicted habitat types which were cross correlated with the biological community types, resulting in a predictive habitat map for the German EEZ.

4.5 Denmark

Johnny Reker presented the National Status Report for Denmark. Denmark currently has no national strategy for mapping marine habitats. Over the last year focus has been on establishing a national marine network (MariNet) in order to take marine habitat mapping forward within the Danish EEZ. MariNet was established in September 2004. It consists of 11 central governmental institutions under the Ministry of the Environment, Ministry of Food, Agriculture and Fisheries, Ministry of Traffic, Ministry of Defence, Ministry of Culture and Ministry of Energy. The members of the Steering group are senior managers with high-level influence who plan to meet four times a year. There are also a number of working groups, which handle relevant technical issues. The purpose of MariNet is:

- Development of national strategies
  - A strategy for co-ordinating national marine efforts
- A national marine strategy
  - Legal obligations
  - identify and clarify national and international obligations
- Characterisation of marine areas
  - agreed level between multiple stakeholders
  - define, describe and apply for funding of specific projects of broad interest
- Co-ordination of infra-structure
  - Prioritisation of national effort through identification of responsibilities, gaps in knowledge and common goals
  - Co-ordination of field effort (ships, instruments, personal)
- Optimisation of data management (access to data and merging of traditionally distinct data sets and databases, e.g., navy and environmental data).

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3 Rachor, E. and Nehmer, P. 2003. Erfassung und Bewertung ökologisch wertvoller Lebensräume in der Nordsee: Abschlussbericht. [Description and assessment of ecologically valuable environments in the North Sea: final report]. Alfred-Wegener-Institut für Polar- und Meeresforschung: Bremerhaven, Germany. 175 pp

Denmark has also, over the last year, taken the initiative to formulate the BALANCE Interreg IIIB project proposal (see section 3.1.4.1).

4.6 Ireland

Fiona Fitzpatrick (Marine Institute) presented the National Status Report for Ireland. Currently, within Ireland seven mapping projects are currently underway. These are:

a) The Irish National Seabed Survey (Geological Survey of Ireland and the Marine Institute)
b) The MESH project
c) Annual groundfish and pelagic surveys (Marine Institute)
d) Orange Roughy survey
e) Marine Institute Cross Service Pilot Project
f) Scallop stock assessment project (CMRC & BIM)
g) Loch Hyne project (CMRC & NUIG)

Summaries of these mapping initiatives are given in Annex 9.

4.7 Netherlands

Dick De Jong (RIKZ), with Elze Dijkman and Jenny Cremer (Alterra-Texel), provided the Netherlands report.

Rijkswaterstaat activities:

1) The development of a habitat classification system for benthic habitats in marine and estuarine waters is finished (the ZES-classification). The classification is compatible with the EUNIS-system. This classification system is based on a number of physical parameters:
    a) salinity: mean and variation
    b) substratum: solid or soft; soft: mud → sand → gravel
    c) depth: depth below sea level and time of exposure to the air
    d) hydrodynamics: maximum current and maximum wave energy; wave energy as length of wind exposure and orbital velocity. For littoral areas the geomorphology is an important source for hydrodynamic energy.

    Part of the classification system is the development of the so called 'habitat mondriaan'. This is a coloured scheme, to be added to the habitat map, which depicts the habitats present in a water body in an orderly, structured way. It helps the user of the map to interpret the habitats on the maps more easy.
2) In addition to the classification, habitat maps are composed of the more important water bodies, Wadden Sea, Westerschelde, Oosterschelde and North Sea (DCS). The coastal zone of the North Sea is only roughly mapped.

    For the Westerschelde also older habitat maps can be reconstructed, with the help of geomorphological maps (from 1935). This is important, e.g., to reconstruct a reference situation including the reference developments in habitats.
3) The development of a pelagic habitat classification for marine and estuarine waters (PES). The main parameters used so far are:
    a) salinity: mean and variation
    b) turbulence: based on depth and current: $T = (v^2 / (d \times g)) \times 1000$, in which v = current velocity; d = depth; g = gravity
    c) residence time
    d) stratification

This classification is expected to be completed in 2006. Its compatibility with EUNIS is not clear yet but it is one of the goals to do so. The impression is that PES will only fit in at a high level in EUNIS.

Alterra-Texel activities contribute to the MESH project:

Alterra is improving the detail of habitat maps for the Wadden Sea, and possibly also for the North Sea, intending to go beyond EUNIS levels 4 and 5. These will include specific habitat types (defined as eco-elements in the Dutch literature), such as mussel beds and cockle beds. The next step (2006) will be to include maps with information based on the occurrence of endobenthic organisms, based on field samples and correlations with abiotic factors. Modelling, based on historical data, has created a potential habitat map for mussel beds.

In the North Sea the main aim is to develop maps that can be used for spatial planning (determination of areas to be protected, or areas relatively suitable for specific use (e.g., wind-farms, sand-mining) or for operational activities, e.g., oil pollution. In these maps pelagic features (fish, birds) are also included.

Alterra and TNO will investigate in 2005 the sediment composition, height of tidal flats and benthic communities in the area south of Ameland, using remote sensing techniques (satellite, airplane and ship-based). A similar study will be carried out in the subtidal western part of the Wadden Sea. In the intertidal, relationships between sediment composition and benthos will be examined; whilst in the subtidal the emphasis is on biogenic structures and their relationship with environmental factors such as depth, current speed and sediment type.

4.8 USA

Becky Allee, who was not able to attend the meeting, submitted a briefing on the recent development in the US of a coastal and marine ecological classification standard (CMECS)[4] which is intended to provide a framework for habitat classification. The report would be published shortly.

4.9 UK

Neil Golding (JNCC) described an 18-month project *Broad-scale mapping of the seas around the UK* (Annex 10), which commenced in autumn 2004[5] to extend the marine landscape classification developed for the Irish Sea[6] to the rest of the United Kingdom Continental Shelf area. The project is currently in the data collation phase. Feedback from a wide range of stakeholders during the ISP consultation phase had led to the development and refinement of the methodology applied in the Irish Sea. Additional data layers for natural disturbance, bottom temperature and photic depth will now be used for mapping the seabed features. The more simplified approach to mapping pelagic features adopted in the ISP will be modified to use sea surface temperature, mixing regime, salinity, and temperature/salinity relationships. The more dynamic nature of pelagic habitats will be expressed by creating four seasonal maps for the water column.

For both the water column and the seabed marine landscapes, many different datasets of varying resolution and quality have been used. A confidence map will be produced that reflects the different datasets incorporated into the map.

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4 Madden, C.J. and Grossman, D.H. 2004. A framework for a coastal/marine ecological classification standard. NatureServe, Arlington, VA.

5 For more information on this project, contact Paul Robinson at Paul.Robinson@jncc.gov.uk

6 Irish Sea Pilot: www.jncc.gov.uk/IrishSeaPilot

The resulting broadscale maps will form part of the UK contribution to the MESH project.

Mike Robertson (Fisheries Research Services) outlined the two-year project HabMap, which commenced in April 2005 as a pilot study building on the fieldwork undertaken and results obtained during the EC-funded MAFCONS project. Samples and information gathered in the 2003 and 2004 MAFCONS surveys will provide benthic and fish community data from sites that will now be surveyed acoustically, thus allowing investigations into the link between habitat heterogeneity and species diversity. Identification of structural features that provide essential habitat for a variety of vertebrate and invertebrate species is essential to furthering the ecosystem approach to fisheries management.

To classify seabed habitat, a series of small "intensive survey" boxes (3nm by 3nm) across the North Sea (about 20 sites) and west of Scotland (about 15 sites) will be mapped using AGDS (RoxAnn) and multibeam systems. Each site will be the area immediately surrounding, and including, the track of trawl samples collected for the IBTSs (coordinated International Bottom Trawl Survey (Quarter 3 North Sea and Quarter 4 West Coast IBTS cruises will be used in this pilot). Sediment samples will be collected for calibration of the acoustic equipment and to classify acoustic clusters identified during a PCA analysis carried out in Multiview. Further to this, where possible, infaunal samples will be collected at these positions.

ICES rectangles, which include an intensively surveyed 3 nm by 3 nm box, will then be examined to determine how representative the habitat type and variability observed in the small boxes are of the larger ICES rectangles in which they are contained. This information could be useful in future GFS (ground fish survey) design, *i.e.* in assessing the extent to which single trawl samples in particular ICES rectangles might be expected to provide representative samples of the fish assemblage occupying each rectangle.

4.10 Poland

Andrzej Osowiecki (Maritime Institute in Gdansk) provided the National Status Report on marine habitat mapping activity in Poland. He indicated that neither survey scheme nor national monitoring programme of marine habitats mapping has been carried out in Poland so far on a regular basis.

However, several projects completed in the last 5-year period comprised elements of habitat mapping:

1993–1996: 3 out of 5 Polish Baltic Sea Protected Areas (BSPA) were mapped within the project on natural valuation of the BSPA. Underwater video techniques, biological and physical sampling were used. Maps of i) natural values, ii) sources of threats and degradation, and iii) aims of protection were elaborated according to HELCOM standards (nautical 1:50 000).

2002–2003: acoustic techniques (echosounder and sidescan sonar) were used in pilot monitoring of underwater meadows in the area of Puck Bay (western Gulf of Gdansk).

In 2002 a pilot project of identification of anthropogenic objects by remote methods was carried out on the Gdynia harbour road (Gulf of Gdansk). An integrated system for marine measurements was applied.

Further details are provided in Annex 11.

4.11 Belgium

Els Verfaillie (University of Gent) presented: Geostatistics as a tool for predictive modelling of the Belgian continental shelf.

For the mapping of soft substrata, the sedimentology (e.g., grain size, silt-clay%) is an important factor to explain the occurrence of macrobenthos. Generally, there is a large amount of sedimentological samples, while its interpolation can be difficult over complex seafloors. The amount of macrobenthic samples is generally small.

The aim of this study is to obtain a full coverage map of the physical habitat, starting with the median grain size. Another aim is to provide an estimation of the error of the result of predictive modelling. The output of this model will serve as an input for other models (*a.o.* Marbiol_Ugent model) to obtain a full coverage map of the biological habitat.

The methodology consists of four steps:

1) Large scale zonation and cleaning of data:

Delineation of large morphological entities based on bathymetry (digital elevtion model or DEM), slopes

2) Geostatistics = kriging techniques:

These techniques allow taking advantage of the spatial correlation between neighbouring observations to predict values at unsampled locations. Multivariate geostatistics use secondary information such as a full coverage digital terrain model, which assists in the interpolation. When there is a correlation between the primary (grain size) and secondary variable (bathymetry), it is possible to produce a more accurate prediction of the first variable. The use of the bathymetry as secondary information is very valuable because it is available as full coverage information (DEM) and it is cheaper to obtain than samples.

3) Modelling of relationship between macrobenthos and physical data:

Biological models, using a relationship between the sedimentology and biological species and communities are produced by the Marine Biology Section of the Ghent University.

4) Refinement of zonation:

Delineation of top, flank, swale, foot of sandbanks based on full coverage maps of sedimentology, surficial geology, hydrodynamics, sediment transport. The small scale zones serve as entities for: biological valuation, anthropogenic impacts and control units for the relationships between physical data and macrobenthos

Two results of geostatistics are compared: ordinary kriging with the use of an anisotropic variogram and kriging with external drift. The second technique is a multivariate technique which calculates a trend between the first (grain size) and second variable (bathymetry) in each interpolation window. It is very useful, because the secondary information is available as full coverage information and because there is a correlation between both variables of 0.46. The results are two maps of the median grain size on the Belgian continental shelf. Using cross validation and jack knifing as validation techniques, validation indices were produced, from which MSEE (mean square estimation error) is the most important. The jack knifing MSEE index shows that kriging with external drift has a result which is 15,7% better than the result of ordinary kriging.

The relevance of this model is that the sedimentology is crucial for mapping macrobenthos in soft substrates (e.g., Wu *et al*., 1997[7], Leecaster, 2003[8], Van Hoey *et al*., 2004[9]).). The most

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7 Wu, R. S. S., and Shin, P.K.S. 1997. Sediment characteristics and colonization of soft-bottom benthos: a field manipulation experiment. Marine Biology, 128: 475−487.

important parameters are the median grain size and the silt-clay percentage. Furthermore, the output of the physical models serves as an input for biological models. The map of the median grain size will be used as an input for several biological models, which look for relationships between the grain size and species or communities. The result will be a full coverage map of the macrobenthos.

Future results are a full coverage map of the silt-clay percentage, the sedimentology using the Folk-Ward classification and other physical parameters relevant for biological models.

4.12 Finland

Jan Ekebom (Metsähallitus) gave the Finnish National Status Report.

The Finnish government accepted the National Baltic Sea Protection Programme in 2002. However, the implementation of this programme is not possible at present due to the knowledge gap on the marine environment and its condition. Finnish underwater nature inventory programme VELMU was launched in 2004 to collect data on the diversity of marine biotopes and species. The programme is a cooperation between six ministries with a time frame of 12 years. The work will be realised through a project built on five working packages using a wide range of methods collecting physical, geological and biological data. The programme will produce a data service system, marine landscape maps and habitat maps (scales 1:250 000 -> 1:50 000 on three levels), predictive models, and guidelines for inventories and management.

Geological Survey of Finland is conducting the ongoing National Geological mapping of the Finnish Territorial Waters. Methods used are: echosounder, side-scan sonar, seismic reflection, multibeam echosounder, different sediment sampling techniques and video from which digital geological maps are generated with bathymetry and sediment grain size.

The Metsähallitus Natural Heritage Services is currently carrying out its MERLIN inventory programme which is an integrated part of the national VELMU inventory programme. Metsähallitus is in charge of obtaining new field data for the VELMU programme and also the main provider of this type of data. MERLIN has as a goal to compile marine and coastal habitat and species data in GIS. Its objective is to provide GIS data and thematic maps that can be used for management of the governmental marine and coastal areas administrated by Metsähallitus (3 million hectares of marine waters). The methods used by MERLIN include; GIS modelling, aerial photographs, underwater drop video, scuba diving, underwater still photography and species sampling. The maps are divided into regional maps (1:50 000–1:500 000) and local maps (1:5000−1:50 000).

4.13 Portugal (Azores)

Fernando Tempera (University of the Azores) described projects and tasks related to habitat mapping in Portugal, focusing on the Azores archipelago.

Two projects for establishing littoral and sublittoral biotope descriptions and classifications are currently ongoing around two of the Azorean islands. Data from the biological surveys

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8 Leecaster, M., 2003. Spatial analysis of grain size in Santa Monica Bay. Marine Environmental Research, 56: 67−78.

9 Van Hoey, G., Degraer, S. and Vincx, M., 2004. Macrobenthic community structure of soft-bottom sediments at the Belgian Continental Shelf. Estuarine, Coastal and Shelf Science, 59: 599−613.

performed to inform the selection of management measures for marine SACs is also of potential use for obtaining sublittoral habitat records for the remaining islands (LIFE-Nature project MARÉ and INTERREG IIIb project OGAMP).

An inventory of seamounts is already available for the Azores EEZ sub-area, as well as a comprehensive study of the demersal fish assemblages on them from scientific long-line cruises.

References were also made to past and ongoing work on:

- development of autonomous platforms for mapping purposes (AUV, ASV), initiated with the MAST3 project *ASIMOV*, continued under the FCT-PDCTM project *MAROV* and ongoing through the AdI project *MAYA*;
- participation in the FP6 project *EXOCET* project under which technologies and methodologies will be developed to map deep-sea assemblages, namely hydrothermal vent environments;
- mapping of the *Codium elisabethae* (Chlorophycota) biotope;
- a database of geo-referenced historical records and present locations of deep-sea coral by-catch;
- biogeography of mesopelagic fish;
- movements, habitat preference and occurrence of a selection of fish (FCT project *MAREFISH*), cetacean (FCT project *CETAMARH*) and turtle species;
- development of an exposure index for oceanic coastlines;
- production of mesoscale synoptic maps of temperature and ocean colour based on satellite imagery which are valuable for pelagic biotope mapping.

Work on soft bottom habitats mainly concentrates on (i) surveying underwater sand beds for management of extraction activities, (ii) study of soft-bottom assemblages in areas potentially suitable for mariculture, (iii) and pocket beach dynamics.

At a national level, a working group under the scope of the Portuguese Ministry of Foreign Affairs has been established to prepare a claim for the extension of the country's continental platform under UNCLOS. A programme of hydrographic surveying to prepare the claim has been started within and outside the current EEZ with the Hydrographic Institute R/V *D. Carlos I* which is being fully allocated for the task.

Other projects relevant to WGMHM have been taking place at mainland Portugal and Madeira archipelago led by local universities and institutes, but a comprehensive inventory was not available at the time of the meeting.

4.14 Observations on the national programmes

The confidence level and quality of habitat maps was considered very important and it was noted that the majority of studies appeared not to assess or present confidence levels in the data and maps. It was recognised that assessing confidence was a complex issue, relating to:

- Quality of the underlying data (e.g., standards for individual techniques, integration of techniques)
- The degree of interpolation between data points.
- Confidence in the relationship between environmental variables and the biota.
- The quality of the habitat classification system used.
- The precision of boundaries to habitat polygons.

It was observed that the variance of the estimate from geostatistical techniques can be used as a confidence level, although this cannot be interpreted in an absolute way. The kriging variance is more a measure of the density of samples than an estimation of error. For a more ac-

curate estimation of error, geostatistical techniques such as indicator kriging or stochastic simulations can be used.

It was considered that policy makers and managers should be made aware of the accuracy of maps that they use to make informed judgements and/or management decisions. **WGMHM recommended** that confidence levels are presented both in the maps and the underlying data on which the maps are based.

5 Protocols and standards for habitat mapping

5.1 Definition of the terms habitat and marine landscape/seascape

Develop a working definition of the terms habitat and marine landscape/seascape for the purposes of mapping (ToR h)

A number of definitions of the term 'habitat' from the literature on marine habitat mapping were examined. The suitability of each was discussed, highlighting their strengths and limitations. The meeting recognised that a composite of the available definitions was required and developed the following definition:

Habitat: "A recognizable space which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular spatial and temporal scales."

For the marine landscape/seascape terms, Neil Golding proposed a working definition based on recent work in the UK. Delegates aired differing views on their understanding of the terms which varied from something relating specifically to topography to a wider concept encompassing a collective of habitats and physical features. A concept in which a range of habitat types occur together with some level of interdependence (e.g., as in an estuary or seamount) appeared to encompass the group's understanding of the term. It was observed that the term seascape was used in some countries (e.g., Wales, Scotland) to reflect the visual scenery observed at the surface of the sea (from land) and should thus not be confused with the concept of describing underwater scenery (of the seabed). The potential use of the terms within forthcoming legislation highlighted the importance of reaching a consensus working definition.

WGMHM recognized that the proposed definition for the term habitat needed further explanation of the underlying issues and that the landscape/seascape definition should draw upon existing definitions (for terrestrial ecosystems). Christopher Cogan, Dick de Jong, Johnny Reker, and Brian Todd offered to produce such a short review of existing definitions, and provide accompanying explanatory text for the proposed definition of the term habitat. This was completed by email correspondence following the meeting and is presented at Annex 12.

5.2 Guidelines for habitat mapping

Further progress of the development of guidelines for habitat mapping, including the review of developments of protocols and standards for habitat mapping within the MESH project and other relevant initiatives (ToR i)

The European MESH project had undertaken a review of standards and protocols for seabed mapping techniques and technologies in 2004. This had been the subject of a workshop in November 2004, followed by compilation of the reviews (see http://www.searchmesh.net, search for 'Review of standards and protocols); these had been circulated to WGMHM delegates prior to the meeting with a view to gaining feedback on their utility and thoroughness.

WGMHM considered to reviews to be particularly helpful in drawing together from disparate sources the existing knowledge on a wide range of techniques, and provided some constructive comments on the document.

It was noted that many of the reviews adequately covered standards and protocols relating to the acquisition of data but were somewhat limited in their coverage of the subject of data interpretation, particularly for video imaging techniques and multibeam bathymetry. The aerial photography techniques could be extended for application in mapping intertidal sediment types rather than just for vegetation cover. There was a need for a review relating to the use of single beam acoustic technique, which the French had found useful to detect kelp coverage on shallow-water rock outcrops.

Dick de Jong was aware that another EU-funded project was currently working on intertidal mapping and may be able to provide further guidance on appropriate standards and protocols. Jørgen Leth indicated that the Norwegian Geological Survey had a series of standards and protocols relating to interferometric sonar that would make a useful addition to those already cited in the relevant review.

WGMHM considered that a useful extension to the reviews would be the development of a decision tree to aid in the planning of new surveys, including a table summarising the capabilities and limitations of the spectrum of sampling techniques over various spatial scales and habitat types. Roger Coggan informed delegates that this was likely to be included within the forthcoming work of the MESH project, forming part of a guidelines document on habitat mapping that would be produced in 2007.

Delegates were asked to identify habitats that they had found particularly difficult to survey with the techniques available, or circumstances that caused particular difficulty in applying the techniques. A major difficulty appeared to be in surveying the near-shore surge/surf zone as this was often hazardous to access by boat, diver or ROV and often not readily amenable to survey by aerial techniques. There was no apparent technological solution to this problem. Rather, it was a matter of accessing this type of area during ‘windows of opportunity’ presented by favourable weather conditions. It was noted that the Irish National Seabed Survey had found reduced effectiveness of some acoustic survey techniques under certain hydrographic conditions: strong thermocline or pycnocline conditions affected multibeam surveys (as they influenced the speed of sound in water), and rain or dense phytoplankton blooms increased signal noise in sidescan sonar.

Jacques Populus led a discussion on the utility of survey techniques for shallow water areas, looking at the incremental benefit obtained by using progressively higher resolution remote imagery techniques, with a view to identifying where each technique gave most benefit in differentiating shallow water habitats. This will provide further assistance for survey planning. Indications were also given of the adequacy of guidelines at each incremental stage. The work would be incorporated in the guidance on marine habitat mapping being produced as part of the MESH project.

In discussion it was recognised that different collection methods for biological data (e.g., differing sampling devices) can lead to differing habitat types on maps for the same site. There is therefore an underlying requirement to have some form of quality assurance. Standardizing techniques would alleviate some of these problems, for example using still or video photography and backing it up, or ground truthing it, with grabs.

WGMHM welcomed the work of the MESH project and looked forward to further opportunity to contribute to the developing documentation on this important aspect of marine habitat mapping. As one of the functions of the MESH review process was to highlight areas of deficiency in the protocols and standards, in order to focus attention on where further developmental work was required, WGMHM members were invited to provide any additional comments they

may have by the end of May 2005. An updated version of the MESH reviews would be posted on the project web site in late summer 2005.

5.3 Metadata standards for marine habitat mapping

Report on progress in the development of metadata standards for marine habitat mapping (ToR j)

The increasing importance of metadata is widely recognised as survey technologies advance and diversify and there are growing requirements for quality assurance of data and for indicating levels of confidence in the resulting maps. Many remote survey techniques need to be adjusted/tuned at the time of survey to optimise their performance under the prevailing conditions (e.g., survey platform, weather conditions *etc.*) and it is therefore undesirable to be prescriptive about the way in which the systems should be set up. Rather it is important to record the conditions under which the data were gathered so these factors can be taken into consideration during subsequent data interpretation phases. For several ground-truthing techniques it is important to record information that qualifies the resulting data (e.g., sieve mesh size used in processing grab samples).

At WGMHM 2004 a draft set of metadata fields, relating to a suite of survey/sampling techniques, was tabled and discussed. The feasibility and utility of recording these data fields was assessed during MESH survey work in 2004, but further development was necessary. The latest version of the metadata fields had been circulated to the WGMHM participants prior to the meeting, with a view to providing a basis for discussion. Further useful feedback was forthcoming on specific fields that needed to be included for some of the techniques. Delegates highlighted a number of existing meta-data schemes that might help inform the ongoing development, particularly those of the FDGC standard adopted by the USA, and the results of larger programmes aimed at developing metadata standards for Canadian geological surveys (contact Barbe Szlavco). Mike Robertson provided useful examples of metadata sheets used in surveys conducted by the FRS Marine Laboratory (Aberdeen, UK). Further developments within the MESH project would be reported to next years' meeting.

6 Mapping strategies and survey techniques

6.1 Intercalibration and quality control of mapping techniques

Review progress on intercalibration and quality control of mapping techniques. To construct a habitat mapping decision tree that can be applied to various management issues, identifying base requirements and evaluate the incremental values of mapping techniques (ToR f)

Remote sensing calibration

A range of remote sensing calibration activities are planned for 2005, including:

- An Ireland/Scotland consortium that will be testing acoustic systems.
- France will be intercalibrating shallow water systems (photography, Lidar, satellite, multibeam) in September 2005.
- Netherlands intercalibration tests in shallow water of sidescan sonar, single beam sonar, LANDSAT and ship board measurement.

It was noted that calibration of multibeam systems is crucial in hydrographic surveying situations. However, this level of accuracy is not necessarily required in all multibeam survey situations (e.g., for some habitat mapping studies). The consequences of not calibrating or poorly calibrating need to be understood by the data user, *i.e.* repeat surveys will not be accurate. It is therefore important that the level of calibration is recorded in the metadata to indicate the degree of accuracy in the data.

Biological calibration

It is important in the biological aspects of habitat mapping to accurately identify benthic flora and fauna. In the UK, national testing of laboratories for infaunal identification is undertaken under the auspices of the NMBAQC scheme. However, an equivalent process for epibiota species identification, as needed for analysis of underwater video footage, does not exist. For SAC monitoring in the UK, work is underway to encourage the development of such standards (e.g., pre-survey calibration exercises in species identification for survey staff). There is also a web-based epibiota identification testing facility (www.jncc.gov.gov.uk/page-1593) under development. WGMHM recognised the need for further development of epibiota identification standards.

In addition to species-level identification, there is a need to interpret video and photographic images into habitat types in a consistent manner and to relate these to standard classification schemes. The national marine habitat classification for Britain and Ireland version 04.05 (www.jncc.gov.uk/MarineHabitatClassification) holds images of many of the habitats defined in the classification. However, it was recognised that suitable images are lacking for deeper water habitats.

Regarding the habitat mapping decision tree, the review paper for discussion for this section was not forthcoming prior to the meeting and no further development was possible. However, it was still considered desirable that WGMHM address this topic; it was noted that the MESH project would tackle this topic and could bring suitable material to a future WGMHM meeting.

6.2 SGASC activities on acoustic seabed classification

To review the activities of the SGASC relating to acoustic seabed classification (ToR g)

John Anderson (DFO, Canada), SGASC chair, was due to attend this WGMHM meeting to present their final report. However, production of the report had been delayed till May 2005 and was therefore unavailable to WGMHM for review.

In the interim, John Anderson had requested WGMHM to consider the requirements for future development of acoustic systems. The following topics were highlighted as important areas needing further development:

- Autonomous underwater vehicles;
- Small, portable multibeam sonar systems;
- Shallow water acoustic survey equipment;
- Unique platforms for specialised environments (e.g., hovercraft).

7 Uses of habitat mapping in a management context

Review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications (ToR k)

Dave Limpenny (CEFAS, UK) presented an overview of the use of habitat mapping techniques for the assessment of anthropogenic impacts particularly with regard to aggregate extraction and dredge material disposal.

In discussion it was acknowledged that good habitat maps can:

- significantly help end users better understand ecological status and the impacts of anthropogenic activities.
- guide more effective placement of scientific measurement tools (e.g., current metres) in the marine environment.
- inform, and place relevance on, the positioning of national monitoring stations (e.g., for EC Water Framework Directive implementation).
- be used to assess environmental quality (e.g., the extent of particular threatened or sensitive habitat types, such as salt-marsh).
- be used to develop management zoning schemes within MPA's.
- help place the impacts of disturbance into a regional or national context and consequently facilitate the assessment of the significance of potential impacts.

It was generally felt that the user community needed maps at a wide variety of scales, depending on the particular issues to be addressed. The integration of different mapping techniques to achieve end-user needs is considered important; the scale at which this is carried out is dependent on the specific requirements of the end user.

It was noted that the forthcoming GeoHab conference in May 2005 (www.ngu.no/geohab) will address a number of issues concerning uses for habitat mapping, and that the GeoHab affiliation of scientists are preparing a book on habitat mapping and its application. The expected publication is early 2006. It was agreed that WGMHM could usefully review the GeoHab presentations and group them according to their applications. Further work on the range of uses of habitat mapping was considered useful, as a number of delegates had further examples to offer. It may also be possible to get further guidance regarding end-user requirements from habitat maps via other ICES working groups. Such input could be developed into recommendations on how maps should be constructed and how they should be presented to end-users. For example, whether they should be in paper or electronic form and how distinct habitats should be represented on the maps.

Brian Todd pointed out that we need to ensure that we use appropriate terms for scale. Mapping of relatively small areas at relatively high resolution should be described as "fine scale" or "site specific" surveys rather than "small scale", in order to avoid confusing end users.

8 Relevance of habitat mapping to other aspects of marine ecosystems

8.1 North Sea habitat mapping data for REGNS

Extract and compile habitat mapping data at EUNIS level 4 or above at the scale of the ICES rectangle across the North Sea area, and submit this data (in excel spreadsheet format) to the secure REGNS website in preparation of the REGNS Integrated Assessment Workshop in 2005. Also provide maps of sediment characteristics at the scale of the ICES rectangle across the North Sea area (ToR l)

REGNS is a new ICES working group tasked with the regional assessment of the North Sea. Many ICES working groups have been asked to supply information to this WG for a workshop to be help in May 2005. The provision of datasets requested in this action (ToR l) was discussed within the North Sea benthic habitat mapping sub-group with the following outcome.

The request was acknowledged, and the group concluded that it was clear from the considerable effort expended by WGMHM members over the past year that marine habitat data collation and mapping was beyond the scope of the group, within the resources currently available. However, certain WG members have produced potentially suitable marine habitat maps, under independently-funded initiatives (EEA and MarGIS), which may fulfil REGNS requirements. Further details can be found in Annex 6. As Kjell Magnus Norderhaug has the only complete EUNIS habitat map of the North Sea, WGMHM will await the decision of the EEA as to whether the map can be released to REGNS.

8.2 Pelagic mapping in the Bay of Biscay

Yolanda Sagarminaga (AZTI, Spain) presented ongoing research on epi-pelagic habitat classification and mapping in the Bay of Biscay.

Attempts have already been made to deal with the classification and mapping of the marine waters. Longhurst (1998)[10] has classified the global sea into 4 biomes and 57 biogeochemical provinces, whereas Pauly and Pitcher (2000)[11] have classified the world's coastal zone into a number of "Large Marine Ecosystems".

The work presented here concerns a smaller area in the Bay of Biscay which corresponds to the ICES sub-division VIII. The general approach followed consists of carrying out spatio-temporal analysis for various species occupying different trophic levels (primary producers, secondary producers, small pelagic species and large pelagic predators). A habitat characterization for each of the aforementioned groups was performed by studying and identifying the key abiotic or biotic factors affecting their spatio-temporal distribution. Finally, the results from the first two stages will be integrated to derive an epi-pelagic habitat classification. This classification will be compared with proposed habitats and criteria used in EUNIS.

Preliminary results concerning the phytoplankton, the anchovy and sardine and albacore spatial distribution and their relationship with some parameters such as sea surface temperature, sea surface salinity and chlorophyll concentration have shown that both spatial and temporal clustering is needed. Dynamic maps can be produced demonstrating the high temporal variability found in the epi-pelagic zone. The model can also show the species or community distributions with the reference environmental factors at any specified time or date.

The model has standard datasets for environmental variables, linked together by the model's algorithms. Queries can then be run on these datasets to produce maps for a specific range of dates.

Discussion

Discussion on the presentation centred on the taxing nature of modelling the constant state of flux found in the pelagic realm, and how difficult temporal validity is when modelling such systems. The validity of using sea surface chlorophyll in conjunction with fish catch statistics from across the water column was questioned. It was explained that the majority of fish species studied lived in the epi-pelagic zone, *i.e.* in the surface waters, and so were relevant to the

10 Longhurst, A.R. 1998. Ecological Geography of the Sea. Academic Press, San Diego. 398 pp.

11 Pauly, D. and Pitcher, T.J. 2000 Assessment and mitigation of fisheries impacts on marine ecosystems: a multidisciplinary approach for basin-scale inferences, applied to the North Atlantic. *In* Methods for evaluating the impacts of fisheries on North Atlantic ecosystems. Ed. by D. Pauly and T.J. Pitcher. Fisheries Centre Research Reports, 8(2): 1–12.

modelling work. It was also explained that one of the most difficult phenomena to model in the water column was the thermocline, and this still hadn't been tackled by the pelagic modelling community.

WGMHM agreed that the nature of pelagic ecosystem modelling, with its multi-disciplinary approach, meant that it did not fit under the remit of a single ICES working group, but could contribute to many. It was however apparent that the techniques and datasets required for pelagic mapping followed an essentially similar philosophy to that undertaken for the benthic mapping. As such, and because of the importance of associating benthic and pelagic systems in understanding ecosystem structure and function, it was necessary to continue to address both realms in future WGMHM meetings.

9 Any other business

David Connor reminded the meeting of the guidance from ICES on participation in Working Groups as official members and as invited experts by the Chair. Participants were encouraged where possible to become official members of WGMHM, via the national delegates.

Roger Coggan asked whether ICES provided any feedback to the Chair on the adequacy of the reports prepared by WGMHM, particularly in the light of the apparently limited inspection of the report at the 2004 Marine Habitat Committee. David Connor advised that the reports were assessed by ICES against the ToR and that the advisory committees (e.g., ACE) often made good use of the material in the WGMHM reports in the preparation of the advisory committee reports.

10 Election of Chair

As the 2005 meeting was the final year of David Connor's three-year tenure as Chair of WGMHM, he called for nominations for Chair of the Group. Fiona Fitzpatrick (Ireland) nominated David Connor to continue as chair. This was seconded by David Limpenny (UK), Chris Cogan (Germany) and Brian Todd (Canada) and unanimously supported by the rest of the meeting. David Connor gratefully acknowledged the nomination and advised that, if accepted by ICES, he would be pleased to continue to lead the work of the Group as best he could.

11 Actions and recommendations

Fiona Fitzpatrick (Ireland) offered to host WGMHM in Galway, Ireland from 4–7 April 2006. Alternative dates are 25–28 April 2006. WGMHM requested that David Connor contact the chairs of other appropriate WG's and SG's with a view to holding a joint/overlapping meeting in Galway. This is in response to ICES requesting that its WG's and SG's improve their horizontal communication. It is the view of the members of WGMHM that such a shared meeting would be an efficient use of time and could significantly increase the cross fertilisation of habitat mapping ideas across relevant groups and help focus future direction for a more integrated ICES effort in the field of habitat mapping.

Helsinki and Copenhagen were offered as possible venues for the 2007 WGMHM meeting.

The following intersessional work would be undertaken:

1) David Connor to seek views from chairs of BEWG, WGECO, WGEXT, SGASC and WGFAST on improving horizontal communication between the working groups, possibly via a joint/overlapping meeting in Galway in April 2006 (BEWG by 15 April 2005; others by 30 June 2005).

2) David Connor to provide a letter of support to the EEA for continuing the work on the North Sea EUNIS map (by 30 April 2005).

3) Kjell Magnus Norderhaug to discuss with the EEA whether the North Sea EUNIS map and sediment map can be released to the REGNS workshop in May 2005 (by 30 April 2005).

4) Dick de Jong to provide details of the EU-funded intertidal projects using mapping techniques (by 31 May 2005).

5) Fiona Fitzpatrick to seek Norwegian Geological Survey information on standards for interferometric sonar and feed into MESH reviews (by 31 May 2005).

6) All WGMHM members to provide additional comments on the MESH review of protocols and standards for marine habitat mapping (review document available at http://www.searchmesh.net/Default.aspx?page=1442) to Roger Coggan and/or Jacques Populus. (by 31 May 2005).

7) Roger Coggan to seek further information on Canadian metadata standards and feed into MESH metadata standards work as necessary (by 31 May 2005).

8) David Connor to ask ETC/BD about a formal feedback mechanism for comments on the EUNIS classification (by 30 June 2005).

9) Brian Todd and David Limpenny to review EEA and MarGIS reports on North Sea mapping projects and provide a review to WGMHM 2006 (by 31 January 2006).

10) Fiona Fitzpatrick to draft a review of calibration requirements for acoustic survey systems (by 31 January 2006).

11) Neil Golding to provide a draft generic specification for habitat mapping datasets (building upon table developed at WGMHM 2005) (by 31 January 2006).

12) Fiona Fitzpatrick to provide a review of the SGASC report on acoustic seabed classification (by 31 January 2006).

13) Jacques Populus to draft a document linking types, styles and scales of habitat maps to different end uses (by 31 January 2006).

The draft Terms of Reference for the 2006 meeting were recommended and are attached as Annex 13 of this report.

12 Adoption of the report

The draft report and list of annexes was discussed by the Working Group before the close of the meeting. It was circulated to the participants for comments before finalising.

13 Close of meeting

The Chair David Connor thanked Chris Cogan and the AWI staff for hosting the meeting and for providing excellent facilities with which to have such a productive and forward-looking meeting.

Annex 1: List of participants

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Annex 2: WGMHM 2005 Terms of Reference

2E05 The **Working Group on Marine Habitat Mapping** [WGMHM] (Chair: D. Connor, UK) will meet in Bremerhaven, Germany, from 5–8 April 2005 to:

International programmes (Baltic, MESH North-West Europe, North Sea)

a) discuss and propose a strategy for implementing the development of a habitat classification framework and habitat maps for the Baltic Sea [HELCOM 2004];

b) develop a benthic/pelagic habitat map for the North Sea to EUNIS level 4 or similar, based on data sources compiled or made available to the Working Group and compiled into a GIS, and to assess future data requirements and issues arising from the process;

c) compare international habitat mapping methodologies, and work towards a best practice approach;

d) review progress of international mapping programmes (e.g., MESH, EEA, Baltic, ICES);

National programmes (National Status Reports)

e) present and review National Status Reports on habitat mapping activity during the preceding year according to the standard reporting format (presentations limited to 10 minutes per country).

Mapping strategies and survey techniques

f) review progress on intercalibration and quality control of mapping techniques. To construct a habitat mapping decision tree that can be applied to various management issues, identifying base requirements and evaluate the incremental values of mapping techniques (primer document to be circulated 3 months prior to meeting);

g) to review the activities of the SGASC relating to acoustic seabed classification.

Protocols and standards for habitat mapping

h) develop a working definition of the terms habitat and marine landscape/seascape for the purposes of mapping;

i) further progress of the development of guidelines for habitat mapping, including the review of developments of protocols and standards for habitat mapping within the MESH project and other relevant initiatives (a report of the MESH project should be circulated prior to the meeting);

j) report on progress in the development of metadata standards for marine habitat mapping.

Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions)

k) review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications.

Relevance of habitat mapping to other aspects of marine ecosystems (fisheries, pelagic)

l) extract and compile habitat mapping data at EUNIS level 4 or above at the scale of the ICES rectangle across the North Sea area, and submit this data (in excel spreadsheet format) to the secure REGNS website in preparation of the REGNS Integrated Assessment Workshop in 2005. Also provide maps of sediment characteristics at the scale of the ICES rectangle across the North Sea area.

WGMHM will report by 25 April 2005 for the attention of the Marine Habitat and the Fisheries Technology Committees, as well as ACE.

Supporting Information

Priority	This Group coordinates the review of habitat classification and mapping activities in the ICES area and promotes standardization of approaches and techniques to the extent possible.
Scientific justification and relation to Action Plan	Action Plan Nos: 1.4.1, 1.4.2, 1.4, 1.4.3. a) This is a request from HELCOM HABITAT 6/2004. The EUNIS classification and the HELCOM Red List of Biotopes should be taken into consideration as well as other projects in the region such as the CHARM project. ICES has agreed to support MHC/WGMHM in encouraging relevant experts to support this request. Progress will be reviewed in 2005 in discussion with HELCOM. b) WGMHM has worked towards the production of habitat maps for the North Sea, through the assessment of data requirements, considering various approaches to development of broad-scale maps and an initial acquisition of the relevant data sets. The WG has further activities planned over the 2004 intersessional period and needs to progress the development of international-scale maps. This activity is to be undertaken in collaboration with related activities on habitat mapping at the North Sea scale, particularly by the EEA, the Interreg MESH project and within SGNSBP. The geographic area to be covered is from the high water mark to deep water of the North Sea (according to the OSPAR Quality Status Report Region II and ICES areas VIIE, VIID, VIA, IVB, IVC). Preparation: Before the meeting, data will be sourced and converted into GIS map layers for overlaying and active querying during the 2005 meeting. Efforts will be made to allow meeting participants' access to all information layers in advance of the meeting. c) Following the progress of multinational programmes, in particular by NIVA for the EEA and within the Interreg MESH project, will help the WG in its work on a North Sea map; additionally any follow-up to the recommendations by the 2004 WGMHM for Baltic Sea mapping need to be considered. d) The work of the various large-scale and multi-national mapping programmes (e.g., by EEA and MESH) and the ICES North Sea work will provide different approaches, which can be assessed and compared, leading to guidance on suitable generic approaches to tackle the mapping of such large sea areas. e) The compilation of National Status Reports is required to keep abreast of current activities and bring attention to new initiatives, developing techniques and data availability. f) The availability of a range of mapping techniques and the variation in environmental conditions (habitat type, depth) lead to multiple choices in mapping strategies for any given study. Development of a decision tree is required to link the aims/requirements of proposed studies to available resources, the most suitable mapping techniques and to the environmental conditions of the study area in order to derive the best mapping strategies. g) The SGASC will further progress the development of an *ICES Cooperative Research Report* on Acoustic Seabed Classification, at its 2004 meeting and intersessionally. This work is of direct relevance to WGMHM activities. h) A practical working definition of terms is needed to reduce confusion in terminology and promote common understanding and use of terms. i) Continued development of guidelines and standards is necessary to improve the quality of habitat mapping studies, to increase the compatibility of generated data and to facilitate the aggregation of habitat mapping information for national and international reporting purposes. j) Sound data management is important in the archiving and distribution of data sets. Work on this started at the 2004 WGMHM. k) Habitat maps can have many different purposes; there is a need to compile a set of uses for this information, including worked examples, so that the potential application of this resource maps is more widely understood. l) This is in response to a request from the ICES REGNS group. Order of priorities: High: a, c, e, g, h, k – Medium: b, d, i, j – Low: f
Resource requirements	
Participants	Representatives from Member Countries with experience in habitat mapping and classification. Participation of the Baltic countries is particularly sought.

Secretariat facilities	
Financial:	
Linkage to Advisory Committee	ACE
Linkages to other Committees or groups	BEWG and SGNSBP, WGEXT, WGECO, WGFAST and SGASC, SGEH (Baltic Committee)
Linkages to other organizations	OSPAR, HELCOM, EEA
Secretariat Cost share	

Annex 3: Agenda

Tuesday 5 April

1) **Opening of meeting (1000)**

- Appointment of Rapporteurs
- Terms of Reference

2) **Adoption of Agenda**

3) **International programmes (Baltic, MESH North-West Europe, North Sea)**

- *Review progress of international mapping programmes (*e.g.*,, MESH, EEA, Baltic, ICES) (ToR d)*

  Development of EUNIS marine habitat maps for the North Sea (Kjell Magnus Norderhaug, NIVA, Norway for EEA)

  The OSPAR priority habitat mapping programme (David Connor, UK)

  Developments with the EEA's EUNIS habitat classification (David Connor, UK)

  Baltic Sea region (Johnny Reker, Denmark; Eugeniuz Andrulewicz, Poland; Jan Ekebom, Finland)

  Progress with the Interreg MESH programme (Mapping European Seabed Habitats) (David Connor, UK)

  IASC working group for Arctic Coastal Biodiversity Assessment (ACBIO) (Chris Coggan, Germany)

- *Discuss and propose a strategy for implementing the development of a habitat classification framework and habitat maps for the Baltic Sea [HELCOM 2004] (ToR a)*

  Baltic sub-group to discuss; consider role of proposed Interreg Balance project (Jan Ekebom, Finland and Eugene Andrulewicz, Poland to lead)

- *Develop a benthic/pelagic habitat map for the North Sea to EUNIS level 4 or similar, based on data sources compiled or made available to the Working Group and compiled into a GIS, and to assess future data requirements and issues arising from the process (ToR b)*

  North Sea sub-group to continue work from last year (Brian Todd, Canada and David Limpenny, UK to lead)

- *Compare international habitat mapping methodologies, and work towards a best practice approach (ToR c)*

  Working Group Dinner (1830)

Wednesday 6 April

4) **National programmes (National Status Reports)**

- *Present and review National Status Reports on habitat mapping activity during the preceding year according to the standard reporting format (ToR e)*

  (presentations limited to 10 minutes please)

- Canada (Brian Todd)
- France (Brigitte Guillaumont)
- Germany
  - MarGIS (Marine Geo-Information System for Visualisation and Typologisation of the Sea floor (Kerstin Jerosch)
  - Marine habitat mapping within the German EEZ by means of geostatistical methods and classification and regression trees (Roland Pesch)
- Denmark (Johnny Reker)
- Ireland (Fiona Fitzpatrick)
- Netherlands, including a Dutch classification for benthic habitats (Dick de Jong)
- USA (report submitted by Becky Allee)
- UK
  - Broadscale mapping of UK seas (Neil Golding)
  - HabMap (Mike Robertson)
- Poland (Andrzej Osowiecki)
- Belgium – Geostatistics as a tool for predictive modelling of the Belgian continental shelf (Els Verfaillie)
- Finland (Jan Ekebom)
- Portugal (Fernando Tempera)

3) Continued

- Report back from Baltic sub-group
- Report back from North Sea sub-group (allow further sub-group working in afternoon)

5) **Protocols and standards for habitat mapping**

- *Develop a working definition of the terms habitat and marine landscape/seascape for the purposes of mapping (ToR h)*
- *Further progress of the development of guidelines for habitat mapping, including the review of developments of protocols and standards for habitat mapping within the MESH project and other relevant initiatives (a report of the MESH project should be circulated prior to the meeting) (ToR i)*

  Led by Roger Coggan, UK and Jacques Populus, France, based on review of mapping protocols and standard undertaken with the MESH programme. See http://www.searchmesh.net/Default.aspx?page=1442 and particular questions provided in 2nd announcement for the meeting.

- *Report on progress in the development of metadata standards for marine habitat mapping (ToR j)*

Thursday 7 April

6) **Mapping strategies and survey techniques**

- *Review progress on intercalibration and quality control of mapping techniques. To construct a habitat mapping decision tree that can be applied to various management issues, identifying base requirements and evaluate the incremental values of mapping techniques (primer document to be circulated 3 months prior to meeting) (ToR f)*

  NB – this document has not been prepared in advance of the meeting as anticipated

- *to review the activities of the SGASC relating to acoustic seabed classification (ToR g)*

7) **Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions)**

- review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications (ToR k)

  Use of habitat mapping techniques for assessing anthropogenic impacts (David Limpenny, UK)

  3) Continued

- Report back from North Sea sub-group, including presentation of maps (?!)

8) **Relevance of habitat mapping to other aspects of marine ecosystems (fisheries, pelagic)**

- *Extract and compile habitat mapping data at EUNIS level 4 or above at the scale of the ICES rectangle across the North Sea area, and submit this data (in excel spreadsheet format) to the secure REGNS website in preparation of the REGNS Integrated Assessment Workshop in 2005. Also provide maps of sediment characteristics at the scale of the ICES rectangle across the North Sea area (ToR l)*

  North Sea sub-group to pay particular attention to this ToR.

- Pelagic mapping in the Bay of Biscay (Yolanda Sagarminaga, Spain)

9) **Any other business**
10) **Election of Chair**

Friday 8 April

11) **Recommendations and Actions**
12) **Adoption of the Report**
13) **Close of Meeting (1300)**

Annex 4: Report of the Baltic Sea sub-group

Background

HELCOM (HELCOM HABITAT in May 2004) has requested ICES to make a first draft of a marine landscape map for the Baltic Sea. The ICES WGMHM was expected to respond to the request at its meeting in Bremerhaven, Germany, in April 2005. The request was inspired by the Delphi approach done a few years ago in Australia. This approach use of a group of experts that jointly, based on their subjective opinion, compile a rough draft map. Such a draft map, with all its flaws, will then trigger the countries involved to identify what data sets are needed to improve the draft map and to identify what data sets are missing.

ICES WGMHM Baltic Sea representation

Due to the fact that participants from only three Baltic Sea countries (Poland, Denmark and Finland) participate in the ICES WGMHM meeting can only partly respond to HELCOM's request. The response is described in detail below.

HELCOM REQUEST 1

Marine landscape (definition given by the ICES WGMHM meeting 2005):

Broadscale geological/physical and hydrographic features which can act as a surrogate for a biological community. WGMHM will provide a definition of marine landscapes based on a literature review.

Ways to apply marine landscape maps

Marine landscape maps can for example be used for identifying bio-geographical regions on a regional sea level such as for the Baltic Sea.

Marine landscape maps help to address questions such as:

a) Representativity of existing marine protection sites/networks e.g. is the network of HELCOM BSPAs representing all the bio-geographical regions of the Baltic Sea.

b) How to address the ecosystem approach in spatial planning by identifying areas with specific features of the seabed as well as the pelagic landscapes.

c) identify "blue corridors" between sites or landscapes of particular interest for the life cycle of species (spawning, nursery areas, resting areas, feeding areas, stops during annual migration *etc.*)

Examples of benthic features are:

- reefs;
- channels;
- banks;
- plains;
- basins, thresholds;
- estuaries;
- archipelagos;
- lagoons;
- areas with specific seabed-type characteristics;
- areas with specific biological characterstics.

Examples of pelagic features are:

- seafronts (permanents, seasonal)
- stratified areas
- areas with specific biological characteristics (e.g., cyanobacteria blooms, zooplankton)

Datasets that can be used for compiling marine landscape maps

The ICES WGMHM meeting can identify the type of datasets that can be used for compiling marine landscape maps.

TYPE OF DATASET	UNIT	APPLICATION
MARINE HABITATS and LANDSCAPES		
Bathymetry (incl. slope/topography)	Meter, gradient	Topography, 3D modelling, slope, ruggedness, bedforms, stability of habitats
Wave exposure/fetch	exposure coefficient (shier)*	identification of potential habitats, range of organisms, orbital velocity
Ice cover , seasonal (surface cover, not anchor ice)	number of ice covered days and area covered	range of sessile organisms, tendency for anoxia in shallow basins
Surficial geology (seafloor typology)	lithology, area cover	identification of potential habitats, range of organisms
Sediment composition	grain size, geotechnical, acoustic and geochemical properties	Habitat complexity, heterogeneity
Maximum current (in given relevant time span)	knots, cm per second, direction	Adversity, identification of potential habitats, mobility of sediment, bottom stress,
Tidal range*/sea level changes	cm, meter	identification of potential habitats, zonation, exposure time (desiccation)
Shoreline (at HAT)	meter	outlining the Baltic Sea basin, GIS modelling
Benthic species	Benthic community	range of organisms, diversity
Temperature (surface, bottom, profile)	°C, (annual range, variability)	Biogeographic zones, special communities
Dissolved gases (oxygen, methane etc)	mg/l	Anoxic area or time period of deficiency, special communities
Water quality (nutrient concentration)	e.g. Tot N. Tot.P	level of eutrophication
Stratification	depth of thermo / pycnocline	
Transparency (Turbidity)	Secchi depth (m)	depth of photic zone, potential habitats, range of organisms
Anthropogenic impacts	multiple	Habitat modifiers
Salinity	PSU (max, min, range, rate of change)	potential habitats, range of organisms
Occurrence/frequency of algal blooms	Species, Chlorophyll, µg/l	presence absence in a specific area, areas occupied with large standing stocks of microalgae
Mixing regimes	cover (km2)	
Historical records		Past status of habitats

* e.g., Isaeus 2004

HELCOM would benefit from getting a list of the available datasets that can be used for marine landscape mapping from each of the HELCOM Contracting Parties. An example of a useful data collection format is provided in the Appendix

Recommendations and suggestions for ways forward

Recommendation 1: The idea to make a first draft for a marine landscape map for the Baltic Sea Region (BSR) at the WGMHM meeting is, despite the good intentions, not achievable due to the limited number of participants from the BSR. We recommend that HELCOM or an international project in the BSR compile the datasets needed for marine landscape mapping and make an attempt to produce a first draft map. The approach used and the draft map can then be taken to the next ICES WGMHM meeting for peer review.

Recommendation 2: Assessment of existing work made for producing marine landscape maps. This would require a thorough review of the existing literature on marine landscape maps. How these maps can be applied and what are the advantages/ problems with such maps should be described.

In addition to the existing literature the experiences from ongoing or planned projects that aim at producing marine landscape maps should be used to identify useful approaches, protocols, useful datasets and technical methods. The data quality assessment (production of confidence maps) should be given particular attention.

Recommendation 3: The HELCOM CoPs would benefit from a common data compilation format that can be used by HELCOM or projects in the Baltic Sea Region for producing marine landscape maps. The compatibility of these data sets should be assessed and a common data format should be agreed upon.

Recommendation 4: A draft map of the marine landscapes of the Baltic Sea should be done through an international project or initiative for the whole Baltic Sea and not for the individual Baltic Sea nations to avoid incompatible maps or various definitions for the same landscape type.

Recommendation 5: The draft map should be sent for international peer review.

Ongoing projects are:

a) The Irish Sea Pilot (in the Irish Sea, www.jncc.gov.uk/irishseapilot.net)

b) Canadian Atlantic, Pacific and Beaufort Sea mapping projects (Canada, Geoscience for Oceans Management Program, gom.nrcan.gc.ca)

c) The MESH project (www.jncc.gov.org/marine/mesh, http:www.searchmesh.net)

d) NIVAs projects (Norway)

e) Baltic Sea Regional Project (BSRP)

Planned projects in the Baltic Sea that include attempts to compile marine landscape maps:

a) The BALANCE -project (applied from the Interreg IIIB programme, decision in June 2005)

b) The national or sub-national inventory programmes, e.g., VELMU in Finland (currently in its pilot phase).

Planned projects in the Baltic Sea that would benefit from marine landscape maps:

a) The Baltic MPA Life (applied from the EU Life fund, decision in May 2005)

If the BALANCE project is funded then HELCOM would most certainly benefit from their results. The HELCOMs request 1 now made to ICES is then likely to be answered by this project.

HELCOM TOPIC 2

ICES WGMHM comments regarding the development of the EUNIS classification for the Baltic Sea

WGMHM recommends that the EEA and European Topic Centre for Nature Protection and Biodiversity (ETC/NPB, in Paris) continue its work on developing the European nature Information System (EUNIS Classification) to fit better for the Baltic Sea. Existing national marine habitat classification systems in the BS should be reviewed in more detail and used for improving the EUNIS classification, in particular the levels including communities (levels 5, 6). This work should be taken forward by a joint international effort (project) to complete the work.

Appendix I. An example of data sheet for compilation of national data sets available (with some examples)

Country 1.

TYPE OF DATA	DATA PRODUCER	DATA FORM	DATA COVER	SCALE	PIXEL SIZE	AVAILABILITY	COMMENTS
Bathymetry	Name of the Institute/agency	point, line, vector	100% of national waters	1:50000	0,5m	For sale or free of charge?	Updated every X years

Annex 5: Generic table of data types for habitat mapping

The ICES WGMHM identified the following types of datasets that can be used for compiling marine landscape and marine habitat maps:

TYPE OF DATASET	UNIT	APPLICATION
Bathymetry (including slope/topography)	Meter, gradient	Topography, 3D modelling, slope, ruggedness, bed-forms, stability of habitats
Wave exposure/fetch	exposure coefficient (shier)* orbital velocity (e.g., for relevant storm conditions *i.e.* depending on the life span of the relevant organisms)	identification of potential habitats, range of organisms, seabed disturbance
Ice cover, seasonal (surface cover, not anchor ice)	number of ice covered days and area covered	range of sessile organisms, tendency for anoxia in shallow basins
Surficial geology (seafloor typology)	lithology, area cover	identification of potential habitats, range of organisms
Sediment composition	grain size geotechnical, acoustic and geochemical properties	Habitat complexity, heterogeneity
Maximum current (in given relevant time span)	knots, cm per second, direction (when possible current near the bottom) (e.g., for relevant tide and storm conditions, *i.e.* depending on the life span of the relevant organisms)	Adversity, identification of potential habitats, mobility of sediment, bottom stress
Tidal range*/sea level changes	cm, meter	identification of potential habitats, zonation, exposure time (desiccation)
Shoreline (at HAT)	meter	outlining the land/sea boundary, GIS modelling
Benthic species	Benthic community	range of organisms, diversity
Temperature (surface, bottom, profile)	°C, (annual range, variability)	Biogeographic zones, special communities
Dissolved gases (oxygen, methane etc)	mg/l	Anoxic area or time period of deficiency, special communities
Water quality (nutrient concentration)	Total N. Total P	level of eutrophication
Stratification	depth of thermo / pycnocline	
Transparency (Turbidity)	Secchi depth (m)	depth of photic zone, potential habitats, range of organisms
Anthropogenic impacts	multiple	Habitat modifiers
Salinity	PSU (maximum, minimum, range, rate of change)	potential habitats, range of organisms
Occurrence/frequency of algal blooms	Species, Chlorophyll, µg/l	Presence/absence in a specific area, areas occupied with large standing stocks of microalgae
Mixing regimes	cover (km2)	
Historical records		Past status of habitats

* e.g., Isaeus 2004

Annex 6: Report of the North Sea sub-group

Sub-group members:

Chris Cogan (AWI, Germany)
Roger Coggan (CEFAS, UK)
Kerstin Geitner (DIFRES, Denmark)
Neil Golding (JNCC, UK)
Kerstin Jerosch (AWI, Germany)
David Limpenny (CEFAS, UK)
Kjell Magnus Norderhaug (NIVA, Norway)
Brian Todd (GSC, Canada)

TOR [b]

Develop a benthic/pelagic habitat map for the North Sea to EUNIS level 4 or similar, based on data sources compiled or made available to the WG and to assess future data requirements and issues arsing from the process.

Background:

During 2004/2005, various applicable datasets were obtained and posted on a working group ftp site, with a further view to developing a North Sea benthic habitat map. To this end, an ArcIMS platform was developed and initiated by Chris Cogan (AWI). Kerstin Geitner was charged with processing datasets on the ftp to a common geographic projection (ftp:\\gsca.nrcan.gc.ca/ICES[1]). The planned activity at the 2005 WGMHM was to initiate the compilation of the North Sea habitat map using the aforementioned datasets. However, it became apparent on day one of the WGMHM meeting that KMN has completed a version of a North Sea habitat map for the EEA. Clearly, the amount of effort expended in obtaining and compiling the disparate data sets need not at this time be duplicated. On day two of the WGMHM, German university researchers presented another version of a habitat map of the North Sea.

Current status:

1) EUNIS level 3 map developed by Kjell Magnus Norderhaug (NIVA) under the auspices of the EEA (European Environment Agency). Supporting documentation to be supplied to the North Sea sub-group.

2) MarGIS: Kerstin Jerosch and Roland Pesch will produce a broad-scale predicted habitat map for the North Sea, but have produced a more detailed geo-statistically derived habitat map for the German EEZ

Future development:

From the presentations made at the WGMHM meeting, it was evident that considerable effort had gone into the production of these prototype maps. It was similarly evident that it would not be within the scope of this WG to prepare a comparable map. Given that two prototype benthic habitat maps of the North Sea will have been developed[2], we see our role as:

1 This ftp site is password protected as a consequence of licence restrictions imposed by data providers.

2 Production of a North Sea benthic habitat map from German academic community is still in progress.

1) ICES WGMHM north sea sub-group members to draft support letter from ICES HQ to the EEA (Kjell's mapping work)

2) Obtain pre-publication version of methodology report for internal review (ICES WGMHM only) for each mapping study.

3) Assess the datasets/methods used in the production of these habitat maps [*by ???*].

4) Based on the assessment, identify appropriate additional datasets (or replacement data sets) that the WGMHM can recommend to the original mappers to improve horizontal resolution[3].

5) Advise on further geo-spatial processing methodologies where applicable.

Funding issues:

The EEA is presently considering the continuation of the initiative *'Holistic mapping of potential occurrence of marine habitats'*. ICES WGMHM would wish to provide a letter to the EEA supporting the development of a broad scale habitat map of the North Sea, outlining the current needs and calls for such maps within the wider international community. If this funding is forthcoming, then the ICES WGMHM will continue to advise under 'future development' (above). If funding is not forthcoming, then this ICES WG will suggest opportunities for alternative sources of further funding outside the EEA.

Kerstin Jerosch (AWI) and Roland Pesch (University of Vechta) are currently carrying out marine habitat mapping work in the North Sea, and anticipate completing their habitat mapping project by the end October 2005. The project titled MarGIS Marine Geo-Information System for Visualising and Typology of the marine Geodata. Floor, has been funded by the BMBF (Federal Ministry for Education and Research) and the DFG (German Research Foundation). This map may be available for use by REGNS ICES group.

Summary:

Although we acknowledge the request by REGNS to supply marine habitat mapping data at EUNIS level 4 or above [TOR L], it is clear from the considerable effort expended by ICES WGMHM members over the past year or so that marine habitat data collation and mapping is beyond the remit (and resource) of the group. However, WG members have produced potentially suitable marine habitat maps under independently funded initiatives, which may fulfil REGNS requirements.

3 Certain key marine data sets require licensing at considerable cost, which may limit their utility for use within this habitat mapping work.

Annex 7: National Status Reports

Organisation, name of contact person*	Geographical coverage (country, region)*	Project title	Date of work, expected year of reporting*	Techniques used (e.g. acoustics, ground-truthing)*	Datasets generated (e.g. bathymetry, physical habitat, biological, photographic)*	Brief description of work (including depth range)	Outputs: Reports, publications, maps, reference lists	Classification used; local (within project), national (state), EUNIS	Targeted end-users
Belgium									
Ghent University, Renard Centre of Marine Geology: Vera Van Lancker	Belgian continental shelf: typical mud, sand and gravel areas	MAREBASSE	2002-2006. Yearly reports	Multibeam echosounder, side-scan sonar, RoxAnn AGDS, Medusa (natural radioactivity), video, different sampling techniques, hydrodynamic and sediment transport measurements	Physical and biological habitat descriptions and distributions, video, bathymetry, acoustic classification maps, large- and small scale modelling results, targeted end-users maps	set-up of integrated assessment framework for marine aggregates, optimisation of seabed mapping and classification, hydrodynamic and sediment transport modelling (depth: 8-40 m)	reports to thje Belgian Science Policy Office, publications, maps, workshops	local; will be updated to EUNIS in the MESH project	aggregate industry, dredging and dumping, windmill industry and their related government representatives
Ghent University, Renard Centre of Marine Geology: Vera Van Lancker	Belgian continental shelf	GAUFRE	2003-2004. Yearly reports	ArcGIS; existing datasets	practical habitat maps as a basis for impact maps on anthropogenic activities	Towards a spatial structure plan for the Belgian part of the North Sea	reports to thje Belgian Science Policy Office, publications, maps, workshops	local; will be updated to EUNIS in the MESH project	all user functions of the North Sea
Ghent University, Renard Centre of Marine Geology: Vera Van Lancker	Belgian continental shelf	BWZee	2004-2006. Yearly reports	ArcGIS; existing physical and biological datasets	zonation based extrapolation of physical datasets to predict benthic communities	Set-up of a biological valuation map of the Belgian continental shelf	reports to thje Belgian Science Policy Office, publications, maps, workshops	local; will be updated to EUNIS in the MESH project	all user functions of the North Sea
Ghent University, Renard Centre of Marine Geology: Vera Van Lancker	Belgian continental shelf	Marine Landscapes on Belgian continental shelf	2005	ArcGIS; existing physical and biological datasets	broad-scale marine landscape map of Belgian continental shelf, using geophysical datasets and validated with biological samples	set-up of a broad-scale marine landscape map of Belgian continental shelf	dissertation, maps	local (detailed marine landscapes) and classification used in UK	all user functions of the North Sea
Canada									
Geological Survey of Canada (Atlantic), (Dr Brian J. Todd)	Canada, Gulf of Maine	Benthic habitat mapping of the Gulf of Maine	April 1, 2003 to March 31, 2006	Multibeam sonar, seismic reflection profiling, sidescan sonar, sediment coring and grab sampling, video and still photography	ESRI ArcGIS coverage including bathymetry, backscatter, sediment grain size, videography and photography, surficial geology and benthic habitat maps	Banks range from 30 to 100 m, troughs and basins reach 300 m; regional multibeam sonar surveys are followed by groundtruth surveys to obtain both regional samples and samples of particular interest	Digital maps published by the Geological Survey of Canada, Digital Atlas of the Gulf of Maine, scientific publications in peer-reviewed journals	Local classification scheme (I.e. northeastern US and eastern Canadian waters) has been developed by tailoring EUNIS and other schemes	Governments (federal, provincial and state), NGOs, fishing industry, hydrocarbon industry, cable and pipeline industries
Geological Survey of Canada (Atlantic), (Dr Vladimir E. Kostylev)	Canada, Eastern Scotian Shelf	Geoscience for Eastern Scotian Shelf Integrated Management	April 2003 to March 31, 2006	Compilation of legacy data on geology and benthos; Collection of seismic, sidescan sonar data, sediment coring and grab sampling, video and still photography	GIS maps of surficial and subsurface geology and habitat type, database of benthic megafana from optical samples and macrofauna from grab samples.	30 to 1000 m water depths, from nearshore to upper shelf slope.	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals	Habitat template based on disturbance and scope for growth as developed and applied to Scotian shelf	Governments (federal, provincial and state), NGOs, fishing industry, oil and gas industry, cable and pipeline industries

Department of Fisheries and Oceans Bedford Institute of Oceanography (Dr Donald Gordon)	Six 10 x 10 km boxes on the Scotian Shelf off eastern Canada (Emerald, Western and Sable Island Banks)	Spatial utilization of benthic habitat by demersal fish	2001-2005 Results will be released when available	Sidescan sonar, single beam seabed classification, DT Biosonics fish assessment, towed (Towcam) and tethered (Campod) video, still photography (both Towcam and Campod), grab sampling and experimental fishing with otter trawl.	Bathymetry Physical habitat (i.e. sidescan, single beam acoustic metrics, video, photos and grabs) Benthic communities (i.e. video, photos and grabs) Fish communities (i.e. Biosonics, video, photos and trawl) Stomach contents of fish	Large team effort including scientists from DFO at both the Bedford Institute (BIO) and the Northwest Atlantic Fisheries Centre; also scientists from the Natural Resources Canada at BIO. Conducting surveys at the six 10 x 10 km study sites. Depth range 40-70 m. Sites selected after analysis of historical groundfish data (32 years). Three sites have the highest probability of encountering juvenile haddock (hot spots) while three sites have the lowest probability of encountering juvenile haddock (cold spots). Selected paired hot and cold spots on each of the three banks. Data are gathered on annual cruises run in September/October after juvenile haddock have settled to the bottom. Different data sets are being compared. Also attempts at data synthesis and extrapolation. Lost all three cruises in 2004 but trying to make up in 2005, including getting multibeam coverage at the six sites.	Multiple outputs are expected including maps, reports at scientific meetings, and publications. Gave some preliminary results at the 2004 GEOHAB meeting in Galway.	No decision yet. Most likely local but done with knowledge of other classification systems. Habitat is being assessed by different tools (i.e. acoustic, imagery, and sampling) and by different team members.	Scientific community, resource managers, offshore industry (e.g. oil and gas, fishing), NGOs, etc.
Geological Survey of Canada (Atlantic), (Dr Steve Blasco)	Canada, Beaufort Sea	Benthic Habitat and Offshore hydrocarbon development in the Beaufort Sea.	April 2002 to March 2007	Multibeam bathymetric surveys, sidescan surveys, photo and video sampling, box cores, grabs.	GIS maps of bathymetry, backscatter, grain size, iceberg scouring rates, benthic biomass and diversity.	0-200 m, as ice conditions permit.	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals.	Habitat template based on disturbance and scope for growth as developed and applied to Scotian shelf	Governments (federal, provincial and state), NGOs, fishing industry, oil and gas industry, cable and pipeline industries
Geological Survey of Canada (Atlantic) and Department of Fisheries and Oceans, (Dr Vladimir E. Kostylev)	Canada, Scotian Shelf and upper slope	Interdepartmental (horisontal) initiative on Scotian Shelf Habitat mapping	April 2002 to March 2005	Compilation and integration of various data on oceanography, biology and geology of Scotian shelf seabed into a decision support system for habitat management.	GIS maps of water temperature, salinity, tidal and circulation currents, bathymetry, sediment grain size, seabed features, productivity regime, light penetration, variability in oceanographic factors. Database on biomass and diversity of benthos. Linked with GESSIM.	30 to 1000 m water depths, from nearshore to upper shelf slope. Large participation of DFO scientists in preparation of ocenaographic maps, and modeling of disturbance and productivity regime.	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals. Regional Advisory Process Report for Department of Fisheries and Oceans.	Habitat template based on disturbance and scope for growth as developed and applied to Scotian shelf	Governments (federal, provincial and state), NGOs, fishing industry, oil and gas industry, cable and pipeline industries

Geological Survey of Canada (Atlantic), Dr. Kim Conway, Vaughn Barrie	Queen Charlotte Basin, Canada	Queen Charlotte Basin ocean management: Benthic habitat mapping, sponge reefs.	April 1, 2003 to March 31, 2006	Multibeam, sidescan, ROV, sampling.	Integrate oceanographic, marine geological and biological data sets to prepare comprehensive description of sponge reefs as distinct habitat	150 – 250 m shelf of British Columbia.	Seabed habitat maps for 6 areas identified by DFO as containing diverse populations of groundfish species; Multibeam bathymetry maps; Establish the extent and conditions that determine the health and survival of the globally unique sponge reefs. Habitat maps of the hexactinellid sponge reef complexes Conway, K.W., Barrie, J.V. & Krautter, M. (2005): Geomorphology of unique reefs on the western Canadian shelf: sponge reefs mapped by multibeam bathymetry. - Geo-Marine Letters, 25/2; Berlin. Whitney, F., Conway, K.W., Thomson, R., Barrie, J.V., Krautter, M., & Mungov, G. (2005): Oceanographic Habitat of Sponge Reefs on the Western Canadian Continental Shelf. - Continental Shelf Research, 25: 211-226, 10 figs., 2 tab.; Amsterdam. Conway, K.W., Krautter, M., Barrie, J.V., Whitney, F., Thomson, R.E., Reiswig, H., Lehnert, H., Mungov, G. & Bertram, M. (2005):	none applied yet	Department of Fisheries and Oceans, Natural Resources Canada, various stakeholders.
Denmark									
Estonia									
Finland									
Alleco Ltd -Jouni Leinikki	Finland	Classification of Baltic marine biotopes - criteria, definitions and EUNIS compatibility	June 2003-April 2004	Literature, existing data	Bathymetry, physical habitat, biological habitat, biotope names	Clasification system, list of found biotopes, criteria for creating new biotopes and instructions for data collection are defined	Final report ready at the beginning of April, 2004	EUNIS, new local	Data collectors, scientists, planners, decision makers

Alleco Ltd -Jouni Leinikki	Finland	Testing marine habitat mapping methods	August2004-December 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0-20 meters	Final Report	EUNIS, new local	Data collectors, scientists, planners, decision makers
Alleco Ltd -Jouni Leinikki	Latvia	Testing marine habitat mapping methods	June 2004-Dec 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0-20 meters	Final report	EUNIS, new local	Data collectors, scientists, planners, decision makers
Alleco Ltd -Jouni Leinikki: CORPI, Sergej Olenin	Lithuania	Biodiversity study and mapping of marine habitats in the vicinity of the Būtingė Oil Terminal, Lithuanian coastal zone, Baltic Sea	June 2002-March 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0-30 meters	Final report	local	Data collectors, scientists, planners, decision makers
Alleco Ltd, Panu Oulasvirta	Finland	Mapping of Natura 2000 habitats in Vuosaari Natura 2000 area	July 2003-April 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0-15 meters	Final report	Natura 2000, (Data for EUNIS and local system is used in the classification project mentioned above)	Planners, decision makers
Alleco Ltd, Panu Oulasvirta	Finland	Mapping of underwater biotopes in Otsolahti, Espoo	08/02	Divers, aquascope	Physical and biological habitats, vegetaton to the species level	Mapping underwater vegetation and biotopes of a sheletred, shallow bay in Southern Finland; 0-7 meters	Final report	local	Planners, decision makers
Alleco Ltd	Finland, Estonia, Lithuania	Numerous underwater nature mapping projects	1991-2001	Divers, aquascope, acoustics, remote video, diver operated video, aerial photography	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0-25 meters	See http://www.alleco.fi/public.html	Local, HELCOM	Scientists, planners, decision makers
Alleo Ltd, Jouni Leinikki and Viktoras Didziulis	Lithuania, Finland	Developing Allmaps tool to assist underwater habitat mapping	June 2001 - still continuing	Desktop work	Predictions of spatial features	Developing a predicting tool and testing it with ground truth data	www.alleco.fi/allmaps/	Any	Scientists, planners, decision makers
Metsähallitus/Natural Heritage Services, Jan Ekebom	Finland	MERLIN/SAVELIN - Marine inventories of the Archipelago Sea	February 2004-February 2007	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	Survey of the marine habitats and species (flora & sessile fauna). Depth range 0-30m. Project is a part of the Natural Heritage Services MERLIN programme and the national VELMU programme	Habitat and speices database, research papers (ready by 2006), photographic database	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers

Metsähallitus/Natural Heritage Services, Michael Haldin	Finland	MERLIN/MERVI - Marine inventories of the Quarc area	February 2005-February 2008	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	Survey of the marine habitats and species (flora & sessile fauna). Depth range 0-30m. Project is a part of the Natural Heritage Services MERLIN programme and the national VELMU programme	Habitat and speices database, research papers (ready by 2006), photographic database	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers
Åbo Akademi University, Christoffer Boström	Finland	"BIOGEO" Linking Marine Key Biotopes and Geological Features: A Pilot Survey of Macrophyte Communities on Sublittoral Moraines	February 2003 to February 2006	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	Mapping of macrophytes on moraine seafloors. This project is a part of the Finnish underwater nature inventory programme VELMU	research papers (ready by 2006), photographic database	Local	Natural Heritage Services (Manag.plans), Researchers
Finnish Environment Institute, Madeleine Nyman	Finland	Finnish underwater nature inventory programme VELMU	ongoing, annual status reports	Wide range of methods to collect physical, geological and biological data.	Marine habitat maps, distribution maps for macrophytes/sessile species	Coordination of the VELMU programme, data management, predictive models	Predictive models, database, general reports, maps	EUNIS?/HELCOM/Local	National and regional authorities in Finland, researchers, public and decision makers
Geological Survey of Finland, Aarno Kotilainen	The Finnish Territorial Waters	Geological mapping of the Finnish Territorial Waters	ongoing, annual status reports	Echosounder, side-scan sonar, seismic reflection, multibeam echosounder, different sediment sampling techniques, video	Digital geological maps, bathymetry, sediment grain size	Survey of the geological composition of the seafloor. Depth range, from the coast to the deepest basins (0-400 m)	Digital maps published by the Geological Survey of Finland, scientific publications in peer-reviewed journals	none yet	Various stakeholders (e.g. national and regional authorities)
Alleco Ltd	Finland	Scientific diver training	Since 1996	Theoretical and practical training methods	Practical skills for planning and carrying out the fieldwork for underwater nature mapping	Training of biologists to work underwater, special emphasis on underwater biological mapping	About 90 professional scientific divers from 8 countries		Scientists, students
Jan Ekebom	Finland	MERLIN/SAVELIN - Marine inventories of the Archipelago Sea	February 2004-February 2007	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	This project is a part of the Natural Heritage Services MERLIN project & Finnish National Marine Inventories (VELMU)	Final report ready in 2006	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers
Michael Haldin	Finland	MERLIN/MERVI - Marine inventories of the Quarc area	February 2005-February 2008	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	This project is a part of the Natural Heritage Services MERLIN project & Finnish National Marine Inventories (VELMU)	Final report ready in 2006	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers

Christoffer Boström	Finland	"BIOGEO" Linking Marine Key Biotopes and Geological Features: A Pilot Survey of Macrophyte Communities on Sublittoral Moraines	February 2003 to February 2006	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	This project is a part of the Finnish National Marine Inventories (VELMU)	Manuscripts (Research papers) ready by 2006, Final report ready in 2006	Local	Natural Heritage Services (Manag.plans), Researchers
France									
SHOM Jean Luc Deniel	France	TCIFMS	2002	Compilation of various sources for nautical charting	Coastline 1: 50 000 Coastline 1: 150 000 Depth contours 1: 150 000	Same coverage as nautical charts in French metropolitan area.	Digital product, formats : DXF, SHOMTC, S57. http://www.shom.fr/fr_page/fr_prod_num/prod_numerique_f.htm		
SHOM Thierry Garlan	France	"G Map" project	1991-2005	Sidescan, multibeam imagery, seismic, grab samples, old lead observations, cores	Sedimentologic and bedform dynamic mapping	Tidal area to 50 m	16 maps published (1994-2003), 5 to be published (2005), Digital product	Local	Fishermen
IFREMER (coord.) Brigitte Guillaumont, Jacques Populus and André Carpentier	France	REBENT, MESH and CHARM	2001-2005	Review based on existing datasets (mainly coarse resolution)	Bathymetry, Seabed type, Habitat, Landscape maps, Fish habitat maps	All depth ranges	Gridded bathymetry (2 scales), Digital maps for seabed type (1/500 000 and 1/50 000), Benthic habitat maps (5 holistic habitat maps and 2 priority habitats published ; 6 holistic habitat maps and 2 priority habitats to be published), Fish habitat maps, Reports http://www.ifremer.fr/rebent/, http://www.searchmesh.net/, http://charm.canterbury.ac.uk/	Seabed type : national harmonised typology, Benthic habitat maps : local (Eunis to be published)	Coastal managers, fishermen and and scientists
IFREMER (coord.) Brigitte Guillaumont, Jacques Populus	Coast of Brittany	REBENT and MESH	2003-2005	Multibeam,sidescan sonar, AGDS, under water video, satellite imagery, airborne imagery, lidar, ground truthing	High resolution : DTM, Digital seabed maps, Digital habitat maps, Vegetation cover grids, Reports	Tidal area to 30 m depth	7 tidal DTM, 3 Digital sedimentologic maps, 1 Habitat map, reports, 4 tidal sites and 4 subtidal sites under study (to be published 2005-2006)	Habitat maps : local, EUNIS under studies	Coastal managers and scientists
DIREN/MEDD	Brittany	Natura	2003-2005	Aerial photographs, ground truthing	Habitat maps on Natura 2000 sites	Tidal area and shallow bottom	3 Digital habitat maps	Natura 2000	Coastal managers
Germany									
Latvia									
Lithuania									

Netherlands									
RWS-RIKZ Dick de Jong PO Box 8039 NL-43330 EA Middelburg 31-118-672284 d.j.djong@ rikz.rws.minvenw.nl	North Sea Wadden Sea, Oosterschelde, Westerschelde(and saline lakes)	Habitat classification	2005	echo sounding, aerial photographs, different models	Maps for bathymetry, exposure time, max current, waves, salinity	Making habitat classification (ZES)	Habitat classification and hab. maps	Local, EUNIS-compatible	Policy-makers
RWS-RIKZ Dick de Jong PO Box 8039 NL-43330 EA Middelburg 31-118-672284 d.j.djong@ rikz.rws.minvenw.nl	Inshore waters: Westerschelde (mainly)	estuarine knowledge of the Wester-schelde (Zeekennis)	2005	echo sounding, aerial photographs, different models	Maps for bathymetry, exposure time, max current, waves, salinity	Making monospecies habitat descriptions (mostly multiregression type)	Monospecies habitat maps		Policy-makers
RWS-RIKZ Dick de Jong PO Box 8039 NL-43330 EA Middelburg 31-118-672284 d.j.djong@ rikz.rws.minvenw.nl	North Sea Wadden Sea, Oosterschelde, Westerschelde (and saline lakes)		2006?	Models, echo sounding	Maps for bathymetry, turbulency, salinity	Development of pelagic habitat classification	Report, maps	Local, when possible compatible with EUNIS	Policy-makers
Alterra Texel Bert Brinkman PO Box 167 NL -1790 AD Den Burg 31-222-369700 Bert.brinkman@wur.nl	Wadden Sea	Mussel habitat Suitability	2002, report 2002, paper	Habitat suitability analysis. Existing dataset	Map for mussel habitat suitability	Calculate by a model, with abiotic and biotic (mussel) input	Report, map		Policymakers
Alterra Texel Norbert Dankers PO Box 167 NL -1790 AD Den Burg 31-222-369702 norbert.dankers@wur.nl	Wadden Sea	Estuarine knowledge, habitat classification, vulnerability maps	2005, 2006	Field data, modelling, cause effect studies, remote sensing	Maps with (potential) occurrence of organisms and value (WFD and BHD) and vulnerability (oil and fisheries impact, disturbance	Combining datasets, GIS and expert knowledge	Maps (possibly seasonal) with short descriptions and Meta-information	Local, but EUNIS compatible up to level 4	Policymakers but especially managers
Norway									
Poland									
Portugal									

Portugal									
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	MAYA - Development of a Miniaturized Autonomous Underwater Vehicle for Habitat Mapping (MAROV and ASIMOV in previous years)	ongoing	mechanical scanning pencil beam, sidescan sonar, ctd, fluorimeter, autonomous plancton sampler, AUV, ASV	bathymetry, backscattering, ctd parameters, pigments	Developping of autonomous platforms for mapping technology (Autonomous Underwater Vehicle, Autonomous Surface Vehicle) (max. 150m deep)	reports	None	scientists
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	OGAMP (and MARÉ in previous years)	2004	scuba surveys	descriptions of benthic assemblages based on a physiognomic approach	Management proposals for marine SACs in the Azores including scuba surveys of the sites and description of benthic assemblages	reports to the Azores Secretary for the Environment, available on the web	data will probably be processed to integrate a EUNIS-tailored classification	scientists and conservation managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	MARINOVA (contact Dr. Eduardo Isidro, PhD student)	2005	surface and scuba-divers' operated grabs	biological descriptions	Reference status/description of the soft-sediment assemblages in areas with potential for installing mariculture cages	reports, papers?	data will possibly be adaptable to integrate a EUNIS-tailored classification	scientists, coastal managers and developers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	GEMAS (contact Frederico Cardigos, PhD student)	2004	seismics and grabs	physical habitat	mapping of sand beds for potential extraction uses (shallow sublittoral to max 80m-deep)	reports to the Azores Secretary for the Environment, available on the web	None	scientists, coastal managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	Modelling of coastal wave exposure (contact Fernando Tempera, PhD student)	2005	Desktop modelling work	swell exposure map of islands coast	Development of an coast exposure index (littoral and shallow sublittoral)	map, publication	None	scientists
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	MARMAC (task responsible Rogério Ferraz)	2006	scuba surveys		Implementation of monitoring schemes in marine SAC (0-40m)	ongoing	data will possibly be processed to integrate a EUNIS-tailored classification	scientists and conservation managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	CETAMARH - Ecology and population structure of bottlenose dolphins and sperm whales in the Azores: assessing the relationship with habitat features (task responsible Mónica Silva, PhD student)	2005	visual census of cetaceans and data from fisheries observers programme associated with GIS interpretation and modelling	cetaceans habitats (Tursiops truncatus and others)	Assessment of cetacean occurrence and habitat usage of cetaceans (bottlenose dolphins and spermwhales)	reports, thesis, posters	none	scientists and conservation managers

Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	MAREFISH - Benefits of marine protected areas: testing the theory with field experiments(task responsible Pedro Afonso, PhD Student)	2006	passive and active fish telemetry, in situ behavioural observations by scuba	biological descriptions of habitat usage/preferences	Analysis of movements and habitat selection for a selection of coastal fish species with the aim of testing the theorectical benefits of marine protected areas with field experiments (0-100m)	reports, probably papers	habitats preferences of coastal fish species will possibly be related to EUNIS-compatible habitat types	scientists, conservation and fisheries managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	North Atlantic	Telemetry of loggerhead turtles in the North Atlantic (contact Marco Robalo, PhD student)	2007	telemetry of loggerhead turtles	descriptions of pelagic phase loggerhead turtles' movement patterns in the North Atlantic	Epipelagic environment	reports, probably papers	None	scientists and conservation managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	Classification and Mapping of Benthic Sublittoral Biotopes in Faial Island and Neighbouring Channel (responsible Fernando Tempera, PhD Student)	2007	multibeam, bathymetric sidescan, AGDS, scuba-diving and ROV surveys, desktop models	bathymetry, backscattering, bottom type, wave exposure model, current model,	Mapping and classification of sublittoral biotopes in Faial island and neighbouring Channel to Pico Island (0-60m)	report, probably papers	EUNIS tailored biotope classification scheme	scientists, coastal managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	BANCOS 2004 (responsible Frederico Cardigos, PhD student)	2004	physiognamical visual surveys of pelagic and benthic assemblages with SCUBA and ROV	biotope description, monitoring series of physical properties	Annual survey and monitoring of Azorean seamount tops (0-60m)	reports	none	scientists, conservation and fisheries managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	DETRA (responsible Ana Martins, PhD)	2005	satellite remote sensing, ctd	mesoscale maps of temperature and ocean colour for Azores region, satellite remote sensing validation	Epipelagic environment	reports, papers, maps	None	scientists
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	EXOCET/D - Extreme ecosystem studies in the deep ocean: technological developments (STREP) - (responsible Ana Colaço, PhD)	ongoing	accoustics, ROVs, imagery, sensors	bathymetry	Development of technologies and methodologies to map deep sea assemblages environments such as hydrothermal vent fields (deep sea)	reports, probably papers	None	scientists
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	OASIS: Oceanic Seamounts: An Integrated Study	2004	spatial desktop analysis of bathymetry datasets	seamount inventory for the Azores	Seamount inventory within the Azores EEZ sub-area (max ca. 5000m deep)	map and paper (Machete, Morato & Menezes, in press)	EUNIS habitat	scientists, conservation and fisheries managers

Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	Morphodynamics of Azorean pocket beaches (responsible Dr. Virginie Lafon)	2005	beach profiling	analysis of the littoral soft-bottom habitat dynamics in an oceanic archipelago	Morphodynamics of Azorean pocket beaches (littoral)	communication, possibly paper	none	scientists and coastal managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	Coral collection programme (contact Dr. Filipe Porteiro)	ongoing	examination of local reference collection, collaboration with taxonomic experts, literature review, data mining, collaboration with demersal fishermen, bycatch from own scientific cruises	georreferenced deep water coral occurences	Building up an inventory of locations for historical and present deep water coral georreferenced occurences	database, reference collection	None	scientists and fisheries managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	MAREFISH (task responsible Jorge Fontes, PhD Student)	ongoing	otolith microchemistry	larvae and post larvae habitat prefences for a selection of coastal fish species	coastal and shallow seamounts (max 40m deep)	reports, probably papers	None	scientists
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	North Atlantic	Biogeography of North Atlantic mesopelagic fish (responsible Dr. Filipe Porteiro)	2005	pelagic trawls, data mining, examination of museum collections	biogeography of mesopelagic fish	Biogeographical analysis of the mesopelagic assemblages in the North Atlantic (mesopelagic zone)	thesis	None	scientists
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	Etude de la structure, distribution et dynamique de population de *Codium elisabethae* (Faial, Açores) au moyen de techniques de cartographie des habitats marins à l'aide de robot sous-marin (responsible Damien Sirjacobs, PhD Student)	ongoing	diver-held video and still imagery, image processing, light, temperature and adcp dataloggers, algorithms for automated detection and measurement of *Codium elisabethae* (Chlorophycota)	video and still photo mosaics, description of physical habitat, mapping of potential habitat	Study of the structure, distribution and dynamics of Codium elisabethae assemblages (shallow sublittoral to 30m deep)	poster, reports, probably papers	EUNIS habitat	scientists and conservation managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	Demersal fish assemblages in the Atlantic archipelagos of the Azores, Madeira and Cape Verde	2003	bottom longline fisheries cruises, ctd, spatial analysis	description of demersal fish assemblages	Description of demersal fish assemblages fish assemblages in North Atlantic (seamounts and islands shelf and slope in Azores, Madeira and Cape Verde)	thesis (Menezes, 2003)	own classification	scientists and fisheries managers
Dept. of Oceanography & Fisheries - Univ. of the Azores (Dr. Ricardo Serrão Santos)	Azores	Mapping of island slopes and shelves in Azores Central Group	ongoing	multibeam	bathymetry, backscattering	Analysis of slope geomorphology and identification of potential hazardous areas (50 to 1300m)	reports, papers?	none	scientists and civil protection administration

Dept. of Biology - Univ. of the Azores (Dr. Ana Neto)	Azores	BIOTOPE	ongoing	diver-held imagery, quadrat sampling	biotope description and classification	Littoral and Infrallitoral	reports, papers?	EUNIS-tailored? biotope classification scheme	scientists, coastal managers
Ministry of Foreign Affairs (Prof. Manuel Pinto de Abreu)	Portuguese EEZ and area to be potentially claimed	Mission Structure for the Extension of the Continental Platform	ongoing	hydrographic surveying (multibeam, magnetometer)	maps of physical habitat	Deep sea and seamounts	reports, maps	standards and classifications of Portuguese Hydrographic Institute	scientists and EEZ managers
Faculty of Sciences - Universidade of Lisbon (Prof. Pedro Ré)	mainland Portuguese coast	Padrões, Processos e Variação em Comunidades Intertidais de Substrato Rochoso da Costa Continental Portuguesa: uma abordagem biogeográfica	2000	quadrats	littoral biotope descriptions	Patterns, Processes and Variation of Intertidal Communities in Rocky Substrates of the mainland Portuguese Coast; biogeographic approach	paper (Boaventura et al, 2002)	own classification	scientists
Instituto Superior de Psicologia Aplicada (Prof. Emanuel Gonçalves)	Arrábida (mainland Portugal)	Characterization and Monitoring of rocky shore fish assemblages	ongoing	fish visual census and larval collections over distinct habitat types	description of fish community assemblages associated to different habytat types	Description of sublittoral fish assemblages in Arrábida Marine Park; comparative analysis of fish larval assemblages at different very-nearshore habitats	reports, papers, posters	none	scientists and conservation managers
Centro das Zonas Costeiras e do Mar - Univ. of Aveiro (Dr. Ana Maria Rodrigues)	mainland Portuguese coast	ACOBIOS - Acoustic and biological methods in the assessment of subtidal benthic biotopes in coastal ecosystems	ongoing	acoustics, AGDS and grabs	physical habitat, biological	Mapping of Soft Bottom Habitats on Portuguese shelf	reports and papers	none	scientists
Dept. of Biology - Univ. of Aveiro	Nazaré Canyon (off Portuguese mainland coast)	Description of benthic assemblages in Nazaré canyons off the coast of mainland Portugal	2004	box corers	biological descriptions	Description of soft bottom benthic infaunal spatial variability in Nazaré canyon based on box core samples (2800-4100m)	paper (Cúrdia et al 2004)	none	scientists
Department of Geology - Univ. of Lisbon	Portuguese margin, slope and abyssal plain	Projects including mapping of canyons and potential seismogenic areas off the mainland Portuguese coast	ongoing	multibeam, seismics	bathymetry, backscattering, seismic	mapping of canyons and potential seismogenic areas off the Portuguese coast	reports and possible papers	none	scientists and hazard mitigation bodies
Russia									
Sweden									

United Kingdom									
DARD/QUB: Matthew Service / Annika Mitchell	UK, Northern Ireland: East Antrim maerl beds	part of PhD studies (A. Mitchell)	2003-2005, report early 2006	Multibeam echosounder, RoxAnn AGDS, sidescan sonar, towed underwater video, grab samples, pipe dredge samples	Physical and biological habitat descriptions and distributions, photographic/video datasets, grab infaunal datasets, bathymetry, backscatter	Characterisation of maerl bed habitat (10-35m depth range)	PhD thesis, internal DARD reports, possibly feed into MESH porject	local	DARD/QUB, possibly EHS, possibly MESH partners
DARD/QUB: Matthew Service / Annika Mitchell	UK, Northern Ireland / Ireland / Scotland: Shamrock Pinnacles, Laconia Bank, North Channel Peaks	MESH	2003-2005, reporting expected early 2006	Multibeam echosounder, RoxAnn AGDS, some sidescan sonar, towed underwater video, grab samples	Physical and biological habitat descriptions and distributions, photographic/video datasets, bathymetry, backscatter	Characterisation of reef habitat (20-200m depth range)	Report to MESH partners, GIS project	probably JNCC (MNCR) 04.05	MESH partners
DARD/QUB/SNH: Matthew Service / Annika Mitchell	UK, Scotland, Hebrides	Hebrides Biotope Mapping	2004. Report 2005.	Multibeam echosounder, RoxAnn AGDS, towed underwater video, grabs	Physical and biological habitat descriptions and distributions, photographic/video datasets, bathymetry, backscatter	Characterisation of bedrock reef habitat (40-200m depth range)	Report to SNH, GIS project	JNCC (MNCR) 04.05	SNH
DARD/QUB/JNCC/SNH: Matthew Service / Annika Mitchell	UK, Scotland, West of Outer Hebrides	West of Outer Hebrides Biotope Mapping	2004. Reported March 2005.	Multibeam echosounder, RoxAnn AGDS, QTC-View, towed underwater video, drop-frame video, grabs	Physical and biological habitat descriptions and distributions, photographic/video datasets, bathymetry, backscatter	Characterisation of bedrock reef habitat (40-200m depth range)	Report to SNH and JNCC, GIS project	JNCC (MNCR) 04.05	SNH / JNCC
CEFAS (Keith Cooper) Project Partners: British Geological Survey and HR Wallingford	Southern North Sea (Coal Pit & Inner Gabbard), English Channel (Hastings Shingle Bank)	Assessment of the Re-habilitation of the seabed following marine aggregate dredging	Final report puiblished July 2004. Project now extended for 1 year to collect additional data; supplementary final report in July 2005	Digital chirps sidescan sonar QTC Acoustic Ground Discrimination System Line bathymetry Underwater video Underwater stills Macrofaunal samples Epifaunal samples Groundtruth samples Hydrodynamic data Multibeam Bathymetry	Interpreted sidescan sonar mosaics QTC datasets Infaunal datasets Epifaunal datasets Particle size distributions Sediment descriptions Digital and analog video Digital and analog stills Bathymetric contour maps Hydrodynamic indices	Research project designed to monitor the rate, degree and processes leading to the physical and biological recovery at relinquished aggregate extraction sites. Sites in water depths of less than 50m. Extension work using multibeam to measure dregde track features.	Boyd, S.E. et al. 2003 Preliminary observations of the effects of dredging intensity on the recolonisation of dredged sediments off the southeast coast of England (Area 222). Estuarine, Coastal and Shelf Science 57: 209-223. Boyd, S.E. et al. 2004. Assessment of the re-habilitation of the seabed following marine aggregate dredging (Final Report). Science Series Technical Report. CEFAS Lowestoft, 121: 154pp. Boyd S.E. et al, 2005. The effects of marine sand and gravel extraction on the macrobenthos at a commercial dredging site (results 6 years post-dredging). ICES J. MAr Sci, 62:145-162	Local, and generally relate to the physical description of the substrata (ie disturbed high impact, disturbed low impact, undisturbed/reference)	Office of the Deputy Prime Minister, DEFRA and The Crown Estate, Conservation Bodies, NGO's Marine aggregate extraction industry Wider scientific community

CEFAS (Hubert Rees)	UK coastal waters	Food and Environment Protection Act Monitoring Programme	Continuous	Digital chirps sidescan sonar Sub-bottom profiling QTC/RoxAnn Acoustic Ground Discrimination System Line bathymetry Underwater video Underwater stills Macrofaunal samples Epifaunal samples Groundtruth samples Sediment contaminant analysis Hydrodynamic data	Interpreted sidescan sonar mosaics QTC datasets Infaunal datasets Epifaunal datasets Particle size distributions Sediment descriptions Inorganic and organic contaminant datasets Digital and analog video Digital and analog stills Bathymetric contour maps Hydrodynamic indices	Ongoing commitment to provide advice to UK government to assess the consequences of the disposal of dredged material into the marine environment. Habitat mapping techniques are used widely in this context. Generally in water depths <50m.	A range of internal reports, some of which are available for wider distribution.	Local.	DEFRA
CEFAS (Siân Boyd) (Partners: British Geological Survey & Newcastle University)	North Sea, English Channel	Role of seabed mapping techniques in environmental monitoring and management. (Project AE1033)	Start: April 2001 Report: June 2005	Multibeam Sidescan AGDS Video & Still photos Sub-bottom profiler Trawls Dredges Grabs Sediment Profile Imagery Geo-interpretation	Sampling metadata Bathymetry (line & swathe) Georeferenced sidescan Georeferenced AGDS Video records Benthic infauna Benthic epifauana Still Photo's Particle size analyses Sediment description	Investigating utility & limitations of the various methodologies and the integration of their outputs for surveying & mapping anthropogenic impacts (aggregate extraction, dredge disposal, drag fishing) over various temporal and spatial scales in coastal & shelf waters <100 m deep. Seabed facies interpretations & characterisation. AGDS supervised classifications. Biogeographic variability. Decision trees for spatial planners and survey design. Video interpretations.	A.J. Hewer et al. (2002) Mapping of gravel biotopes: an integrated approach. ICES CM Paper K:01 D.S. Limpenny et al. (2002) The utility of sidescan sonar techniques in the assessment of anthropogenic disturbance at aggregate extraction sites. ICES CM Paper K:04 Eastwood, P.D. et al. 2004. Mapping sediment biotopes as continuous distributions rather than discrete entities with hard boundaries. ICES CM 2004/T:02 Birchenough, S.N.R. et al 2004. Integration of ground-truthing approaches to characterise an area licensed for dredge material disposal off the Northeast coast of the UK. ICES CM 2004/T:03 Coggan R.A. et al. 2004. Developing a strategy for seabed mapping at different spatial scales and resolutions: case study of seabed characterisation in an area of the eastern English Channel. ICES CM 2004/T:04	EUNIS (part) Folk & Wentworth (sediments) Local (seabed description based on acoustic, physical & biotic information)	UK Gov't Dept's OSPAR NGO's Industry Scientific community
British Geological Survey (Ceri James) (Partners: CEFAS & JNCC)	Eastern English Channel	Eastern English Channel Large-scale Seabed Habitat Map	Sept 2004 to Sept 2007	Acoustics (MB, SS, AGDS), Video & Ground truth sampling.	Geophysical, sediment & biological survey data Interpreted layers.	Map a broadscale area betweeen the Isle of Wight and Dungeness(0 deg 30min W to 1 deg E) out to the 'median line' (UK territorial waters)	None yet	Local.	Those involved in management of offshore resources (policy makes, Gov't, Aggregate Industry, Nature conservatoin bodies, other stakeholders).

Annex 8: Marine habitat mapping within the German EEZ (MarGIS)

Marine Habitat Mapping within the German Exclusive Economic Zone (EEZ) by Means of Geostatistical Methods and Classification and Regression Trees (C&RT)

Prof. Dr. Winfried Schroeder (Projektleiter)
Dr. Roland Pesch
Dipl. Geogr. Hendrik Bernhard-Pehlke (wiss. Mitarbeiter)
Institute for Environmental Science, University of Vechta

The project MarGIS intends the combination of Geo-Information-Systems (GIS), research data, and advanced statistical techniques to characterise and identify distinct provinces at the seafloor of the North Sea with regard to the similarity of ecological characteristics. Such an ecological regionalisation often is a prerequisite for marine planning and management needs, such as installation of off-shore wind power plants or the declaration of protection zones (Hughes, 1997; Moog *et al.,* 2004; Reiniger, 1997). The ecoregionalisation approach used in MarGIS consists of two main working steps: (1) By applying geostatistical methods such as variogram analysis and kriging, surface maps are calculated from measurement data. (2) Multivariate statistics like Classification and Regression Trees (CART) and GIS-techniques are then used to calculate sea floor provinces from the kriging grid maps. Since the beginning of the project, kriging maps on temperature, salinity and nutrients (phosphate, nitrate, and ammonium) were calculated and used to derive a habitat map for the German Exclusive Economic Zone (EEZ).

The data used to calculate these surface maps were taken from the database established since the beginning of the project in October 2002. Additional surface data are on sediments and on biotic and abiotic measurements. The data sets were provided by several national and international databases and projects and were integrated in a relational Database Management System (rDBMS). Table 1 gives an overview of all abiotic parameters on which measurement data has been integrated in the rDBMS until now: Nearby 235 000 abiotic data sets have been collected from the International Council for the Exploration of the Sea (ICES), the Marine Environmental Data Base (MUDAB) of the Federal Maritime and Hydrographic Office and the Federal Environmental Agency and the Institute of Marine Research, University of Hamburg (IfM).

Table 1: Abiotic Measurement Data in the MarGIS Database

Parameter	MUDAB	ICES		IfBM
	1982-2000	1976-1998	1999-2002	1984-2000
Alkalinity	29		65	
Amonium	283		1615	1678
Dissolved Oxygen	20051		2190	
Nitrate	8744		3110	2922
Nitrate	9951		2434	2901
Phosphate	11764		3109	3682
Salinity	34351	27744	12314	3718
Silicate	372		3117	3732
Temperature	31222	28114	12362	3738
Sum	*116767*	*55858*	*40316*	*22371*

Sum (all) 235312

MUDAB: Marine Environmental Data Base

ICES: International Council for the Exploration of the Sea

IfM: Institute of Marine Research, University of Hamburg

Raster maps were calculated from the abiotic measurement data by applying geostatistical methods. Amongst others originating from applied geological research to estimate mineral resources and reserves (Krige, 1951), geostatistics is nowadays being used in different terrestrial and marine research fields (Goovaerts, 1997; Lembo *et al.*, 2000; Petitgas, 1996). An example of the results of geostatistical analysis is summarised in Figure 1: By using variogram maps, anisotropies can be accounted for in the kriging estimations. In Figure 1 the variogram map indicates that strong anisotropies characterise the spatial autocorrelation pattern of the spatial temperature distribution. The semi-variogram values in NE-direction (44.6°) reach their sill at a distance of 140 km. In NW-direction the maximum autocorrelation range exhibits 80 km, resulting in an anisotropy ratio of 57%. Figure 1 furthermore depicts the result of the ordinary kriging interpolations. Except for a small area within the inner German Bight with values below 13° C, a continuous decrease of the temperature values can be observed from the coastal areas to the outer part of the EEZ. Further such analyses were performed for other time intervals and parameters by using different kriging techniques (indicator kriging, co-kriging). All maps were described with respect to the global quality of estimation by means of cross-validation.

Together with data on benthic communities taken from Rachor (2002) the geostatistically estimated abiotic grid data were used to calculate a habitat map for the EEZ by means of Classification and Regression Trees (CART). CART uncovers the relationship between a chosen dependent variable and a series of predictor variables by dendrograms. These trees display a hierarchical system of decision rules that allows for classifying objects (e.g., grids) according to the features of the predictor variables. CART calculates classes that are homogeneous with respect to the features of the dependent variable. For the calculations performed here, a decision tree was computed from site specific data on nine benthic communities (dependent variable) and geostatistically estimated grid data on grain size as well as on temperature, salinity, silicate, ammonium, nitrate, phosphate and dissolved oxygen aggregated over a five year period (predictor variables). The resulting decision tree is depicted in Figure 2 where the left branch of the tree is zoomed. From this zoomed cut-out it can be seen that from up to down the portion of one of the nine benthic communities increases stepwise. The end nodes only contain one or two communities. Since each end note is determined by certain decision rules, the tree can be applied to predict benthic communities at sites where such information is not available. By doing this for all geostatistically estimated raster cells within the EEZ including a 40 km buffer, a habitat map can be calculated with respect to the occurrence of benthic communities derived by Rachor (2002). Such a map is depicted in Figure 3.

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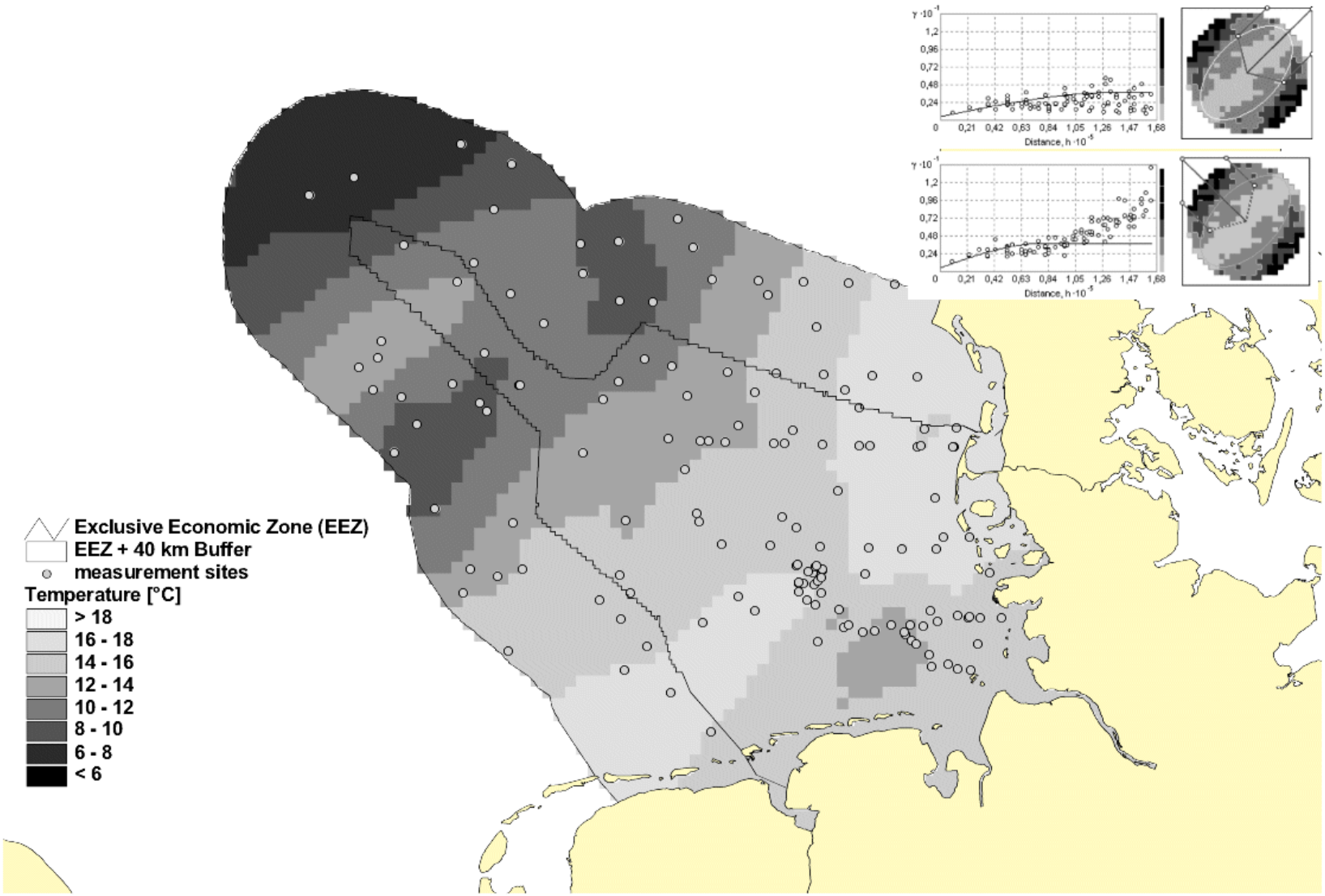

Figure 1: Kriging Estimation of Temperature Data within the EEZ in the Summer of 2000.

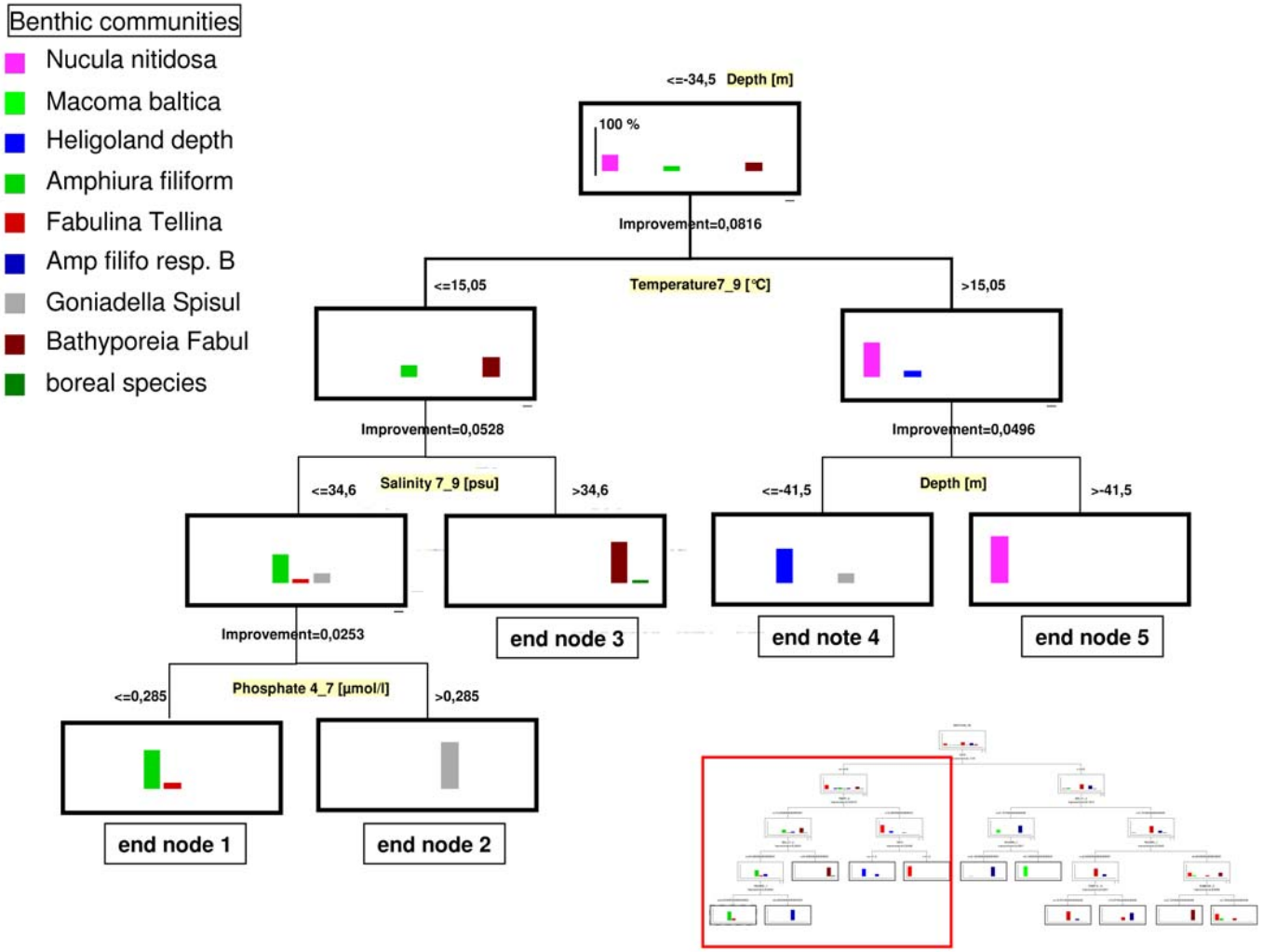

Figure 2: CART-Dendrogram on Statistical Relations of Benthic Communities and Abiotic Factors within the EEZ.

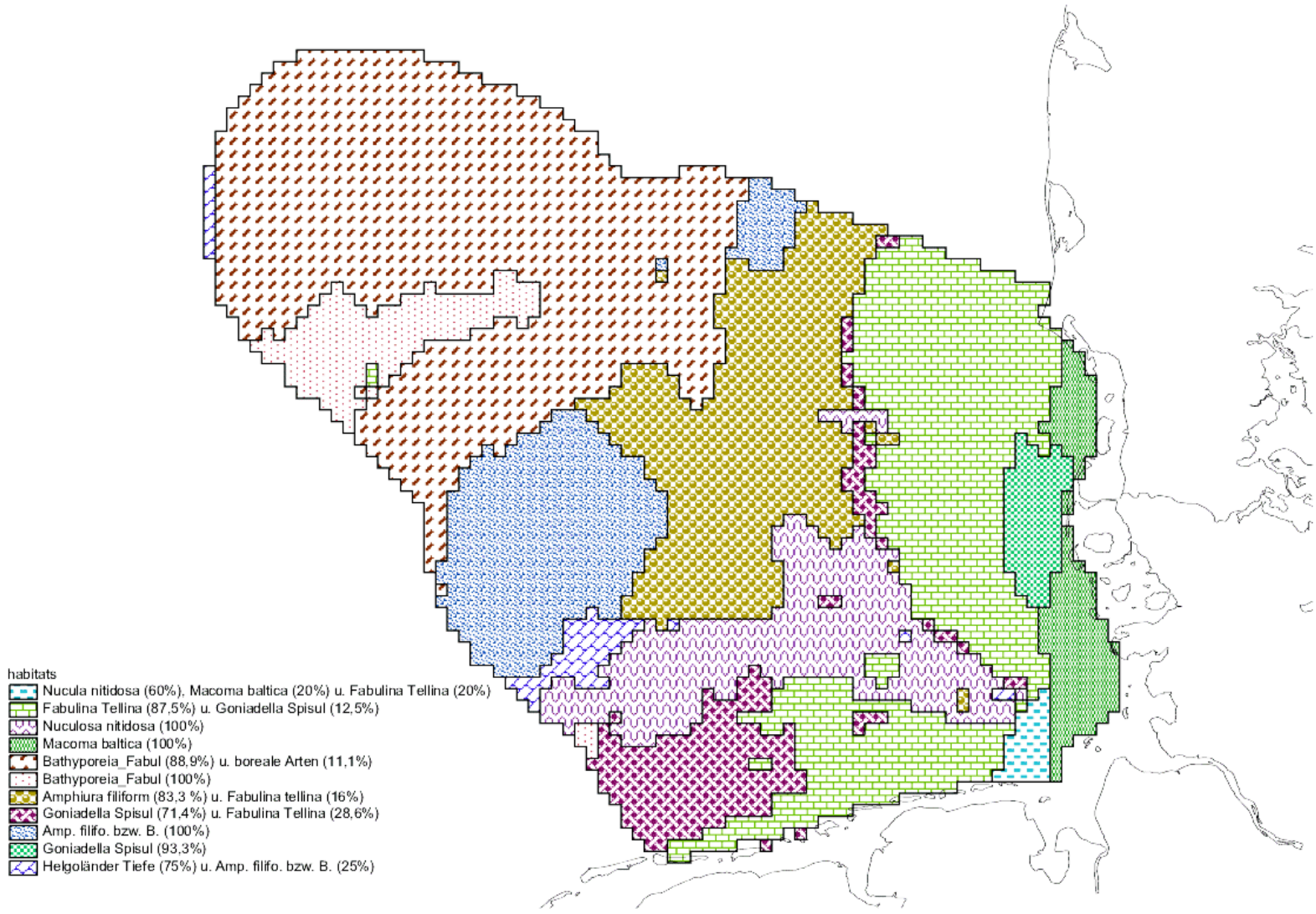

Figure 3: Benthic Habitat Types within the EEZ.

Annex 9: National Status Report for Ireland

a) Developments in marine resource mapping

Organisation(s) undertaking seabed mapping programmes:

Marine Institute (MI) and Geological Survey of Ireland (GSI) – Irish National Seabed Survey

Marine Institute – MESH surveys, Groundfish surveys, pelagic surveys, Orange Roughy survey, Cross Service Pilot Project

CMRC and BIM – Scallop project

CMRC and NUIG - Loch Hyne

Scope of seabed mapping programmes being undertaken in 2004/2005 (please give a brief description of the survey methods employed and the seabed areas which are being mapped)

Irish national seabed survey

In 1999 the Irish Government allocated €32M to fund the Irish National Seabed Survey (INSS) project which was designed to map Ireland's offshore area. The Geological Survey of Ireland (GSI), in partnership with the Marine Institute of Ireland (MI), manage the project and in the last 6 years, over 450 000 km^2 of the Irish Extended EEZ has now been surveyed. During the life of the project, which is now the largest mapping initiative in the world, several vessels and aircraft have been involved. To facilitate management of the EEZ, the area was divided into water depth bands, and between 1999 and 2002, a total of 413 760 km^2 of multibeam, sub-bottom profiler, gravity and magnetic data were collected between the 200 m and 4500m isobaths. From 2002, work concentrated within the Zone 2 area, which spans water depths of 50 and 200m, with any opportunities on passage, etc. to map areas less than 50 m. In 2003 the newly acquired state vessel, the R.V. *Celtic Explorer* began work on the survey. During 2004 season, it was decided that the 50m isobath should not form a limit to survey and work progressed inshore as safely as possible. Seafloor mapping on the R.V. *Celtic Explorer* concentrated in the Approaches to the Shannon Estuary (1002 km^2), Offshore Northern Donegal (2697 km^2), the shoaler, <200 m section of the Rockall Bank (6133 km^2) and a total area of 2388 km^2 of the Biologically Sensitive Area was surveyed. Additionally, the smaller 34 m Marine Institute vessel the R.V. *Celtic Voyager* surveyed an area of 430 km^2 between Carlingford and Howth Head, off the east coast of Ireland.

The Marine Institute vessels are equipped for multipurpose research, incorporating design modifications, scientific and technical instrumentation to efficiently carry out sea floor mapping and hydrographic work to LINZ standards. With the exception of a gravity meter, both the R.V. *Celtic Explorer* and R.V. *Celtic Voyager* are fitted with a comprehensive suite of survey equipment, including an EM1002 (EM1002S) multibeam system and EA600 (EA400) multi frequency single beam echo sounder. The echo sounders receive DGPS positions information from the Fugro HP-Starfix (or SPOT) and roll and heave computations from a Seapath 200 motion sensor, which also acts as the Common Reference Point (CRP) for the vessel payload. Three separate profilers provide the speed of sound in seawater correction for the acoustic sensors. Continuous profiles of the shallow sub sea floor geology are acquired using a 3.5kHz pinger system, comprising a Probe 5000S SBS topside unit interfaced to hull-mounted Massa TR1075D transceivers and triggered and recorded via a Coda Octopus system. The processed and raw output is recorded on both an Ultra paper recorder and to DAT tape. IXSEA Magis magnetometers, accurate to 0.01nT/Hz-RMS, are towed during the survey.

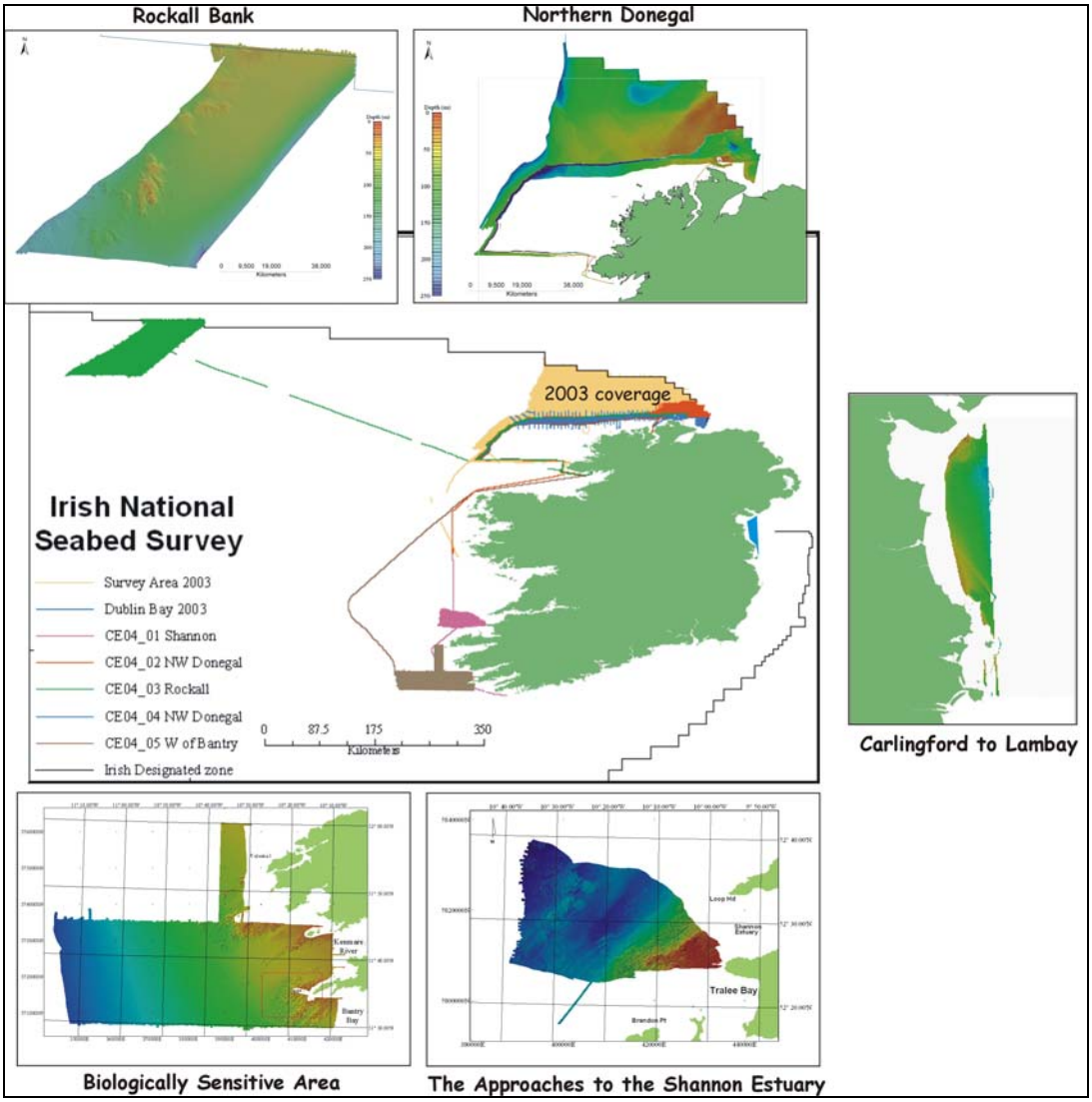

Figure 1 Diagram showing the areas and coverage from the 2004 INSS survey work

MESH surveys

The Marine Institute of Ireland, with the strategic partner the Geological Survey of Ireland, is a partner in the European Commission INTERREG funded international marine habitat mapping programme - development of a framework for Mapping European Seabed Habitats (MESH), which commenced in May 2004. The project is scheduled to last for three years and has 12 partners across the UK, the Netherlands, Belgium and France, covering the five countries in the INTERREG North West Europe area.

The Marine Institute have entered into a strategic partnership with DARD NI and the BGS to build on the MINCH (Mapping INshore Coral Habitats) Project work in order to fulfil the requirements of WP2 and WP3, which deals with the development of habitat mapping protocols. The area selected for survey was required, under the INTERREG regulations, to be cross-border or partially cross border. It was decided to concentrate work on the area of the Donegal Shelf, off Northern Ireland/Donegal extending eastward to the Rathlin Trough in the Northern Irish Sea and northwards to the Southern Hebridean shelf. The selection of this targeted area was based on five qualitfications: *(a)* although the continental shelf in this region has been affected by mulitple pahses of sedimentation, erosion and tectonism, it is essentially a carbonate-dominated environment, *(b)* the general topography has been severely modified by a combination of sea level changes and Quaternary glaciation creating several unique

morphological features for study, *(c)* BGS samples and Irish National Seabed Survey have identified a variety of seabed types (habitats), ranging from muds and mobile sands to gravel and exposed rocks, providing different habitats, *(d)* the exposed rocks are known to be a variety of geological ages and of different composition and '*roughness*', again providing a variety of habitats for comparative study and finally, *(e)* some exposures are known to host *Lophelia pertusa* corals and are classified as potential Annex I habitats, in which further survey is required for groundtruthing purposes. The consortium selected ten sites on the Donegal all with slightly different characteristics. The surveys will be carried out using the MESH protocols and will test the repeatability of the standards on different vessels. In 2004, survey work, within Irish waters, concentrated on Hempton's Turbot Bank, which is located to the east of Inishtrauhull Island 18 km off the coast of Donegal. The Bank covers an area in the region of 15 km^2 and shoals from 40 m to 15 m. The Bank was surveyed during the Irish National Seabed Survey from the R.V. *Celtic Explorer*. The geologists on the vessel passed video locations to the DARD-NI vessel, the R.V. *Loch Foyle,* for video groundtruthing and the R.V. *Celtic Explorer* then returned to the area and carried out an extensive grab sampling programme. Work will continue in this area in 2004, with the aim to build a series of reference keys of matching still and video drop images, single, multibeam and backscatter images and associated sediment and biological sample analysis. Data sets will then be interrogated using multivariate approaches to define associations among biological assemblages and environmental variables including substrata material; associations between these groups and multibeam and backscatter will then be investigated.

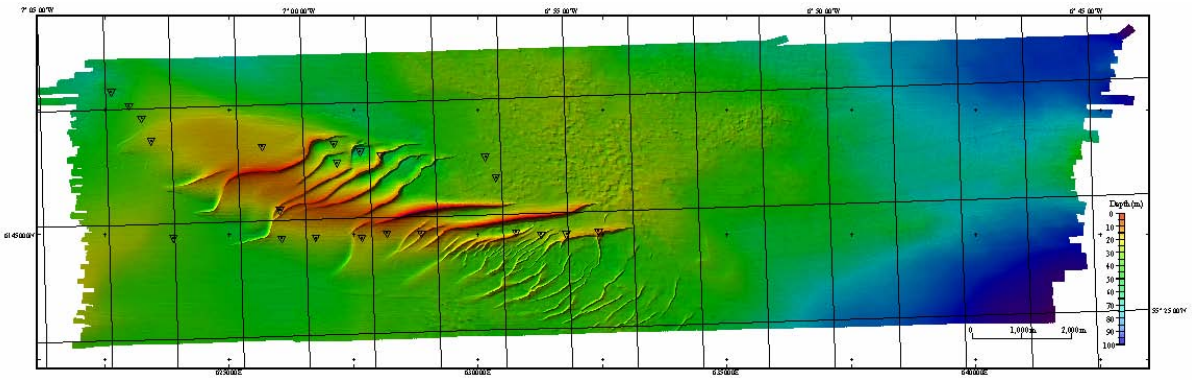

Figure 2: Multibeam bathymetric image of the Hempton's Turbot Bank

Irish groundfish survey

The IGFS is an annual demersal trawl survey carried out by the Marine Institute aboard the *R.V. Celtic Explorer*. It forms part of an international survey programme coordinated by the International Bottom Trawl Survey Working Group (IBTS) under the International Commission for the Exploration of the Sea (ICES). These IBTS surveys extend from northwest Scotland down to the Gulf of Cadiz in southern Spain, out to the Porcupine Bank west of Ireland, and eastward into the North Sea. During the 4th quarter of each year the Irish component of the survey undertakes approximately 160 trawl stations between 50ºN and 56.5ºN, including the Irish and Celtic Seas, and extending westward to the 200 m contour (Figure 3). Since 2003 multibeam and sea floor mapping techniques have been used as a method to: *(a)* successfully locate suitable ground for trawling to mitigate gear damage, *(b)* to identify new trawl locations and, *(c)* map areas of strategic importance to fisheries, such as herring spawning and codling grounds. In 2004, 5541 km of sea floor was mapped during the IGFS, building on the 8400 km acquired in 2003. In addition to recording multibeam and echo sounder data, gravity data were logged continuously through the survey.

Pelagic stock assessment

Sea floor mapping techniques have also been used during the annual Pelagic Stock Assessment work carried out by the Marine Institute. Presently, two herring spawning stocks, one located in Donegal Bay and the other in the Celtic Sea, are under investigation. Herring are known to spawn inshore and are consequently susceptible to anthropogenic disturbances such as aggregate extraction and the dumping of dredge spoils. Multibeam echo sounder, in combination with single beam echo sounder, EchoPlus AGDS and pinger sub bottom profiling have been used to investigate these known spawning grounds. Knowledge of the extent of the spawning grounds, and the location of individual beds within grounds, permits better management and enables instigation of protection measures, such as closing the during key spawning times. Additionally, recognition of key physical characteristics and the associated biota has allowed identification of potential spawning areas.

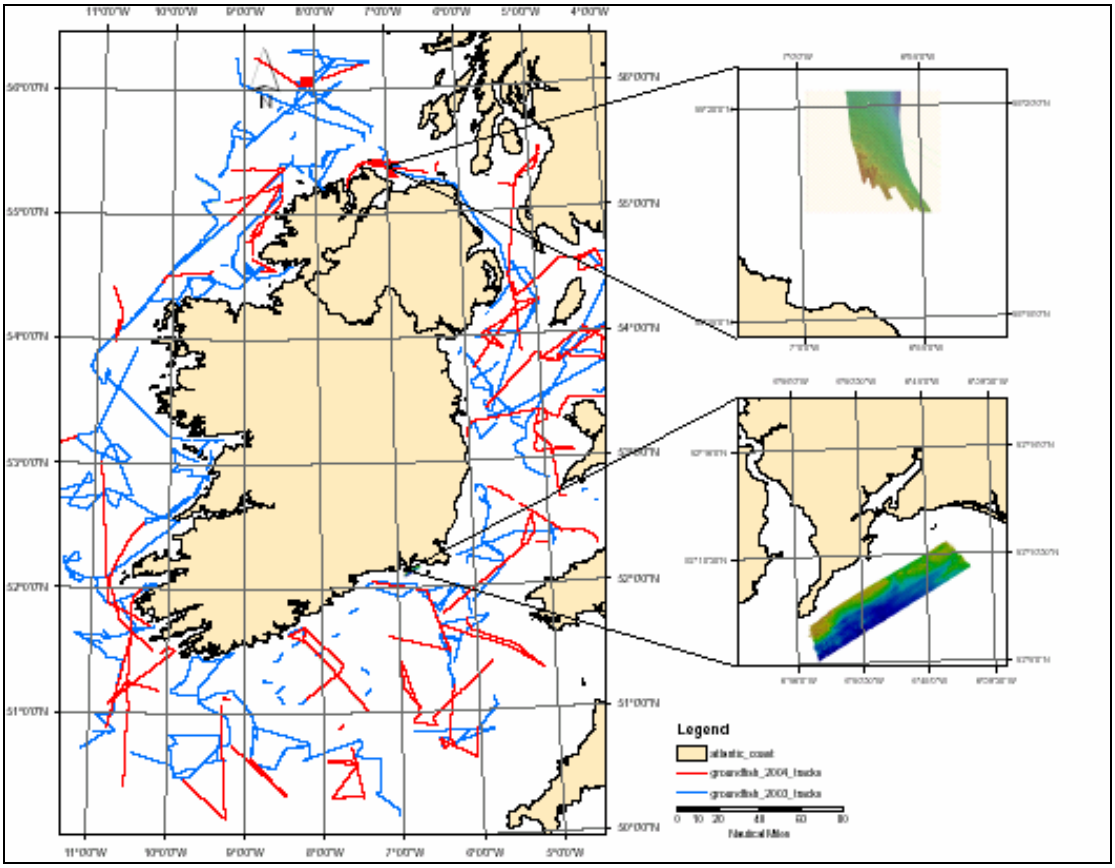

Figure 3: 2003 and 2004 Groundfish trawl sites showing multibeam images of key herring spawning ground in the Celtic Sea and Codling nursery grounds offshore Donegal

2005 Orange Roughy pilot project

The Orange Roughy (*Hoplostethus atlanticus*) is a deep-water fish (800–1500 m), associated with sea mounds and is found in the Atlantic, Pacific and Indian Oceans. The species are slow growing, achieving ages of up to 187 years in Irish waters, maturing between ages of 20–30. In recent years, Irish vessels have developed a new Orange Roughy fishery, although French and Faeroes vessels have fished off the west coast of Ireland since the mid 1990's. Irish landings of Orange Roughy represent 67% of the international catch in ICES Sub-Area VII. At present no management measures are in place and it is essential that assessment methods be developed, to provide the scientific advice required to underpin a management plan for the

fishery. In February 2005, a pilot project was undertaken to assess the Orange Roughy stocks in the deep waters off the west of Ireland from the R.V. Celtic Explorer. Utilising sea floor mapping data, previously gathered on the Irish National Seabed Survey, fished and non-fished deepwater sea mounds on the Porcupine Bank were targeted for investigation. The mounds were then surveyed with a combination of EK60, ROV & Reson 8125 and high-resolution survey on some seamounts to evaluate corals distribution and damage caused by trawling. Samples of Orange Roughy were taken at each of the targeted seamounds and length, weight and age measured to get a stock biomass estimate.

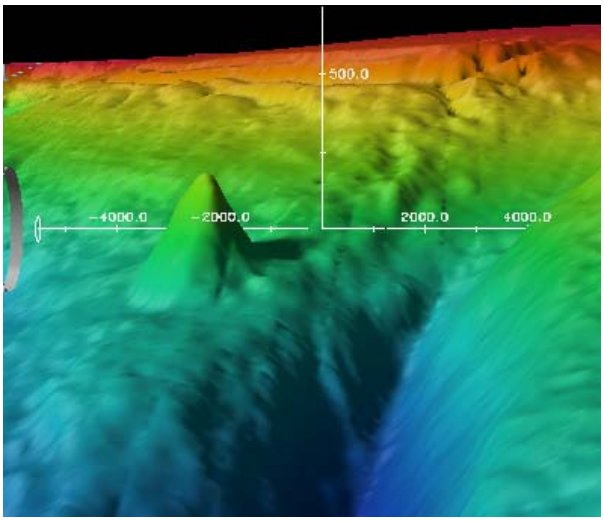

Figure 4: An example of fledermaus 3D visualization.

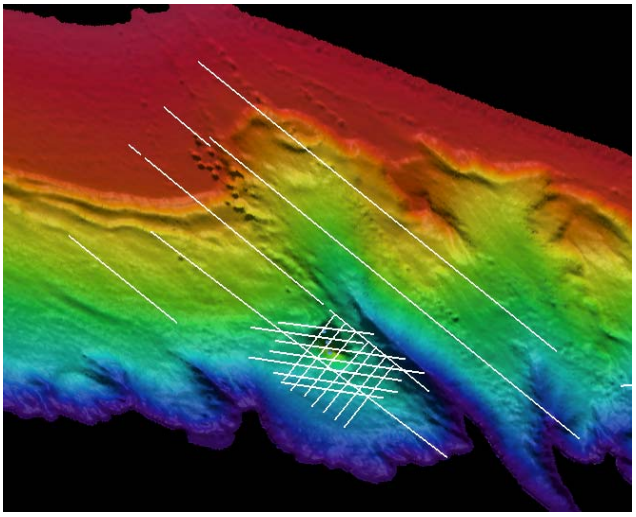

Figure 5: Example of 3d model with acoustic survey tracks overlaid.

Marine institute cross service group pilot project

The Marine Institute comprises seven service groups, including fisheries, aquaculture and ocean sciences, *etc.,* combining a wide and diverse range of specialisations. In order to maximise the value of sea time and obtain 3-D data sets, more applicable to biodiversity studies, it was decided to test integrated cross service work in a specially-designed programme, which would combine measurements of the water column, seabed and benthos. A shallow site was selected off the coast of southern Ireland in a know herring spawning area. The site also includes a harbour-dredge spoil site and comprises areas heavily trawled for scallops. In December 2004 and February 2005, survey work was carried out from the R.V. *Celtic Voyager* in two week-long cruises. Initially the area was mapped using multibeam echo sounder, single beam echo sounder combined with an EchoPlus ADGS system and pinger sub bottom profiling. Video traverses were then carried out, over areas identified by backscatter analysis. Grab and dredge samples were also taken. Vertical plankton samples and CTD profiles were also obtained during the surveys. The Marine Institute are now in the process of working up the results. Initial analysis shows the area west of spoil site features 0.5 m gravel waves in a trough at 20/30 m depth, there is also clear interaction between tidal currents and land mass at the mouth of the estuary. Six classes of acoustic and sample sea floor types have been identified and attempts will be made to correlate these with the resident biota. The video footage review will aim to classify the biotopes to EUNIS Level 5, with a minimum at level 4.

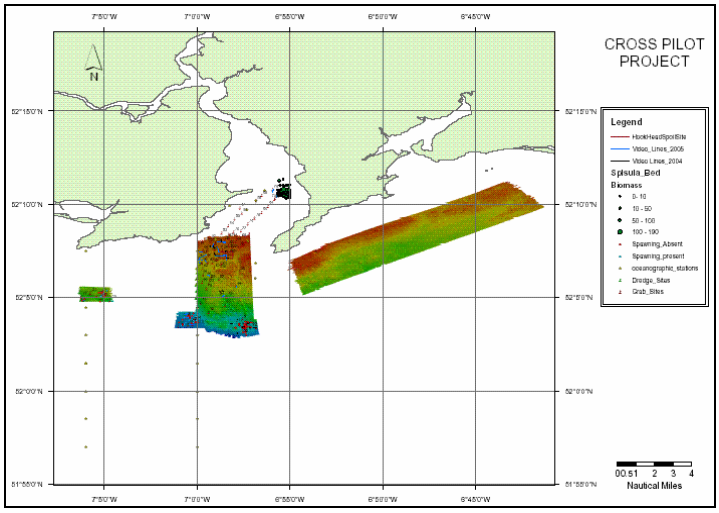

Figure 7: The cross service pilot project Dunmore East, southern Ireland.

Lough Hyne

Lough Hyne, a marine nature reserve, is located 5 km south west of Skibbereen in West Cork. It is a semi closed marine lake and is home to a varied and rich range of plants and animals, including many rare species. It is a highly sheltered seawater basin connected to the sea, via a narrow inlet. The lake measures 0.8 km by 0.6 km. In the past most research of the lake has focused on marine biodiversity. To help address this imbalance the Coastal & Marine Resources Centre (CMRC), and the departments of Zoology, Ecology and Plant Science (ZEPS), Geography and Geology have combined forces to develop an integrated strategic research agenda for the lake that centres on building a thorough and detailed understanding of the evolution and function of the system as a whole. As part of this strategy, the physical attributes of the lake were identified as having been understudied and thus poorly defined. Therefore the first swath bathymetric sonar survey using an interferometric swath sounder was carried out in May 2004. This swath sonar survey has reliably generated close to 100% coverage of the underwater terrain with a high degree of spatial precision. Two datasets were generated concurrently: bathymetry (xyz) and acoustic backscatter. The bathymetric dataset has been gridded to 1m spatial resolution. This can now be used to generate a variety of products including contour plots; sounding plots, and shaded relief imagery as well as digital terrain models. The acoustic backscatter dataset contains information relating to sediment type, which can be used in conjunction with groundtruthing to produce robust habitat maps. Imagery generated from the gridded bathymetry is disseminated and displayed in 3-D by means of newly developed web visualisation technology.

The aim of the web based visualisation system developed here is to examine various geographic datasets, using the Internet as a medium for data exchange. A client-server distributed model is used. The server acts as a central data repository, and makes this data available to clients by means of a web service. This web service is developed using the Apache Tomcat web server and Java Servlet Technology. The server can receive simultaneous data requests from multiple clients and responds by sending the requested dataset to the appropriate client. A client then displays the received data using a three-dimensional viewer. The viewer is implemented using the open source visualisation package VisAD. This package uses Java3D to render interactive 3D scenes either within a web browser (Java Applet) or as a standalone desktop application. Interactive navigation is performed using zoom, rotation and pan functions.

Multibeam sonar mapping and scallop stock assessment

CMRC and BIM have been working since 2002 on a project looking at GIS Data Integration in Support of Sustainable Fisheries Management, in particular looking at scallop populations. Four sites have been targeted for investigation, located off the south coast of southern Ireland. The project is based on work carried out by the USA on scallop stock research sampling programs, which use a stratified sampling regime based on water depth or commercial effort with little emphasis on sediment type derived from available course resolution maps. General knowledge of scallop ecology suggested a preference for sandy and especially gravel-dominated areas. The work of Kostylev *et al.* (2001) demonstrates a strong influence of sediment type on scallop distribution. The work also strongly suggests that scallop abundance and fishing success can be predicted from multibeam backscatter data, an important tool for stock management.

To date the project has gathered multibeam echo sounder data, video trawl and samples. The sedimentary facies in areas presently fished have been interpreted and show the sea floor to be characterised by small sand and gravel waves with organised dune-like bedforms. Comparison with the multibeam backscatter and fishing catches show a good correlation.

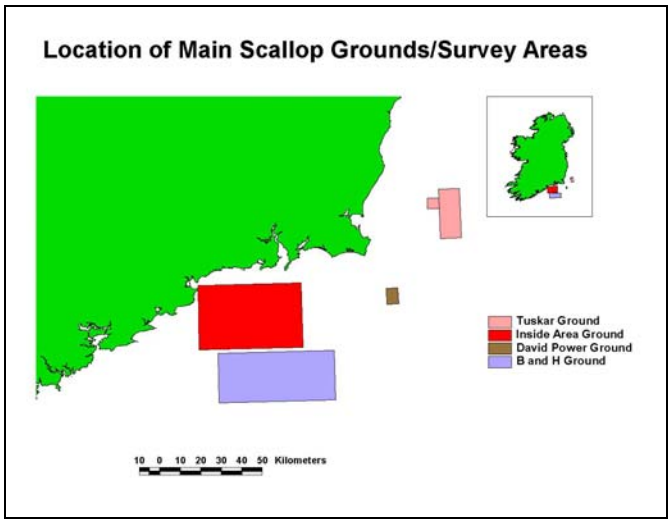

Figure 8: The location of the survey areas.

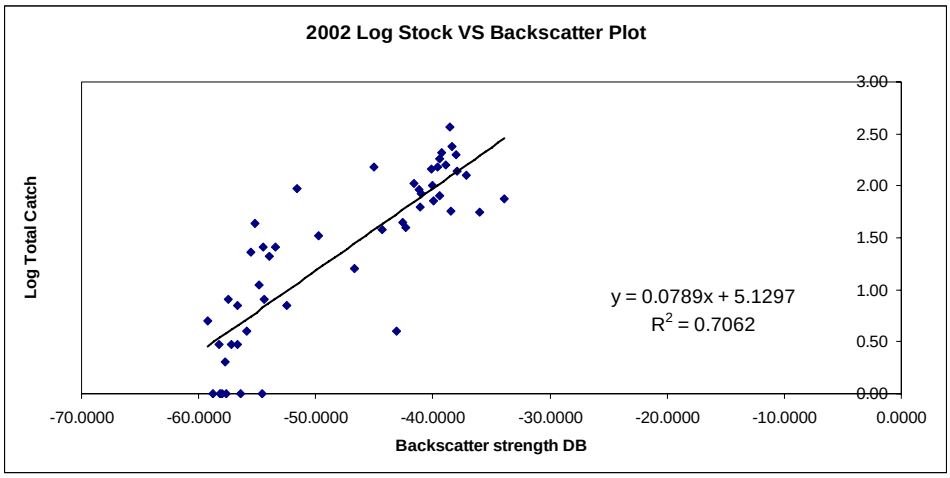

Figure 9: Results to date show the EM1002S data are more than adequate for bathymetric and habitat/biotope mapping and a strong multibeam echo sounder and scallop (stock) relationship exists is present in the survey area. It is considered that sediment sampling alone provide relatively poor groundtruthing and high-resolution video is very useful, indeed a requirement for ground truthing in this type of stock assessment. Problems have been encountered with the near offshore Ireland tidal model, which requires additional resolution and operator settings within the multi-beam.

Published seabed resource maps in 2003/2004 *(please provide details of any seabed resource maps, which have been published in 2003/2004).*

Bathymetric maps representing 2° x 1° sheets at a scale of 1:250 000 and digital data are available for purchase from the GSI.

b) Future marine resource mapping programmes *(please provide details of any planned seabed resource mapping initiatives)*

In 2005, 113 survey days have been reserved by the Irish National Seabed Survey partnership on the R.V. *Celtic Explorer* and 45 days on the R.V. *Celtic Voyager*. The survey areas are: Northern Donegal, building coverage southward on the 2004 survey area; the Approaches to the Shannon Estuary; selected sites within the Biologically Sensitive Area and Cork Harbour.

Additionally, the Marine Institute vessels will be used for 20 days during the INTERREG IIIA IMAGIN project. The purpose of this survey is to establish the nature of a potential aggregate resource located off the east coast of Ireland. The actual size and location of the survey area must still be established. However, the location is expected to be south of Dublin and to the east of the Kish Banks. Marine mapping will be performed using the EM1002S multibeam echo sounder, sub bottom profiler and theEA400 echo sounder coupled with the ECHO plus Acoustic Ground Discrimination System. Magnetometer and side scan sonar will also be towed. A boomer or air gun system will also be deployed in key areas though not necessarily on each and every survey line. Ground-truthing of the acoustic data will be achieved by using grabs (box core/hamon/50gk hydraulic). At least one benthic tide gauge, and two shore-based gauges will be deployed and throughout the survey programme CTD dips will be carried out. Water sediment concentration will be measured. It is possible that some seabed sediment monitoring equipment may be deployed on the seabed, possibly in conjunction with the benthic tide gauges.

Twenty-eight days of sea time have been reserved for the INTERREG IIIA HABMAP Project. The project has some similarities to MESH and will centre on three locations in the Irish Sea. Again, the project will utilise the R.V. *Celtic Voyager*, and work will concentrate on mapping the benthos using a combination of sea floor mapping techniques, including video traverses and sampling.

The ten selected MESH areas will be comprehensively surveyed by a combination of work from the R.V. *Corytes*, R.R.V. *Charles Darwin* and R.V. *Celtic Voyager* during 2005.

c) Other information (please add any further information which you would like to be included in this review)

Reference

Kostylev, V.E., Todd, B.J., Fader, G.B.J., Courtney, R.C., Cameron, G.D.M., and Pickrill, R. A. 2001. Benthic habitat mapping on the Scotian Shelf based on multibeam bathymetry, surficial geology and sea floor photographs. Marine Ecology Progress Series, 210: 121–137.

Annex 10: Broad-scale mapping of the seas around the UK

Developing a marine landscape classification for UK seas

Neil Golding, Joint Nature Conservation Committee, UK

The concept of marine landscapes stems from a paper by Roff and Taylor (2000), where they've developed an approach to map the marine environment in Canada, using geological/physical features, recognising that these are important in determining the nature of biological communities. This approach is potentially well suited for offshore areas where biological information is likely to be lacking, and where the regulation of human activity needs to be addressed at a larger scale. Roff and Taylor considered that this 'marine landscape' approach could be applied to the seabed and the water column using key geological, physical and hydrographical factors.

This marine landscape approach was trialled in the UK (Golding *et al.*, 2004), as part of the Irish Sea Pilot (ISP) project. The pilot was aimed at trialling a 'framework for marine conservation' (Laffoley *et al.*, 2000); a 'nested' framework with four elements: the wider sea, regional seas, marine landscapes, and habitats and species. In the UK at the wider sea level, issues such as pollution and water quality are currently addressed. At the other end of the framework, habitats and species are the traditional approach taken to marine conservation, with established UK and European classification systems. The ISP was tasked with testing the application of the Regional Seas concept, and its constituent marine landscapes. This nested framework approach addresses the ecological requirements of marine wildlife at a range of spatial scales, and the marine landscape classification developed as part of the ISP plays an important role in this framework, as part of the ecosystem approach to marine conservation.

The seabed marine landscape methodology developed for the ISP involved combining data layers for seabed sediments, bedforms, bathymetry, derived degree of slope and maximum near-bed stress in a GIS. These were combined with physiographic features such as estuaries and sea lochs. Criteria were then developed to define draft marine landscape units, and the relationship between these draft marine landscapes units and real biological sample data were tested; there was a valid relationship at the broad-scale. Water column marine landscapes for the Irish Sea were developed using a similar methodology, but using data layers for salinity, stratification and frontal boundaries.

A project extending the marine landscape classification developed in the ISP to the rest of the UKCS (United Kingdom Continental Shelf) commenced in August 2004[15]. The project is currently in the data collation phase. A significant part of the ISP was the consultation phase; feedback was received on both seabed and water column marine landscape maps from a wide range of stakeholders and users, and this allowed for development/refinement of the methodology. In addition to the data layers used in the ISP seabed marine landscapes, natural disturbance, bottom temperature and photic depth will be used. Time constraints imposed during the ISP meant that the water column methodology was a broader, more simplified approach compared to the seabed marine landscapes. The project extending the marine landscapes to the UKCS has therefore allowed the methodology to be refined. A technical meeting was held in February 2005, when lead experts in the field of pelagic ecology and oceanography developed a refined methodology for the water column units. Key data sets which will be used include sea surface temperature, mixing regime, salinity, and temperature/salinity relationships. Prob-

15 For more information on this project, please contact Paul Robinson, JNCC, UK (Paul.Robinson@jncc.gov.uk)

lems were experienced illustrating the constant state of flux which is characteristic of the water column. This will be addressed in the extension work by creating four seasonal maps for the water column.

For both the water column and the seabed marine landscapes, many different datasets of varying resolution and quality have been used. A confidence map will be produced that reflects the different datasets incorporated into the map.

This work carried out under the ISP has shown that the identification and mapping of marine landscape types is fully practical at the regional sea scale, for underpinning management of regional seas, and is economically viable. There was generally good correlation between the marine landscapes identified, the character of the seabed and the biological communities recorded. Marine landscapes can be used to help select a full representative range of biodiversity, with other work done under the ISP using marine landscapes in collaboration with Marxan (a reserve design software tool) to come up with a potential MPA's. This software tool has also just been used to re-zone Great Barrier Reef (30% no take zone). The marine landscape methodology is a promising tool to implement improved spatial planning and management of the marine environment.

The resulting broadscale maps will form part of the UK contribution to a wider European mapping initiative, Mapping European Seabed Habitats (MESH). MESH is being undertaken by 12 partners from the UK, Ireland, the Netherlands, Belgium and France, with the financial support from the European Union, and aims to deliver harmonised maps for NW European seas, and develop standards and protocols to underpin future habitat mapping programmmes. Within the MESH programme, partner countries are keen to replicate the success of the marine landscape classification developed in the UK, and plan to work towards producing a equivalent broadscale marine landscape map for the entire NW European sea area.

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Annex 11: National Status Report for Poland

Andrzej Osowiecki

Neither survey scheme nor national monitoring programme of marine habitats mapping have been carried out in Poland so far on a regular basis.

However, several projects completed in the last five-year period comprised elements of habitat mapping.

- 1993–1996: 3 out of 5 Polish Baltic Sea Protected Areas (BSPA) were mapped within the project on Natural valuation of the BSPA. Underwater video techniques, biological and physical sampling were used. Sets of maps of i) natural values, ii) sources of threats and degradation, iii) aims of protection were elaborated according to HELCOM standards (nautical 1:50 000);
- 2002–2003: acoustic techniques (echosounder and sidescan sonar) were used in pilot monitoring of underwater meadows in the area of the Puck Bay (western Gulf of Gdansk);
- in 2002 a pilot project of identification of anthropogenic objects by remote methods was carried out on the Gdynia harbour road (Gulf of Gdansk). An integrated system for marine measurements was applied (see box);
- The outcome was a set of sonar, bathymetric and bottom sediments map of the area. 309 objects were detected and 205 were examined in detail by ROV (SeaEye 600 DT). A map of categorisation of sea bottom including depth condition, type of surface sediments, degree of pollution, objects concentration on sea bottom was produced.

The Institute of Oceanology, Polish Academy of Sciences in Sopot, is planning to start marine habitat mapping activities in the Polish marine areas of the Baltic Sea. Planned activities will mainly focus on acoustic seabed classification. The institute is equipped with side scan sonar (Edge Tech DR-1000), echosounder (SIMRAD EK 500) and has access to acoustic multibeam sonar (Kongsberg Maritime EM 3000 S). The institute carries its research on RV Oceania.

Up to date research projects were selected to: Zostera beds monitoring in the Gulf of Gdansk, sediment characteristics in the Baltic and the North Seas, measuring size bubbles in marine sediments.

Equipment

Positioning

•DGPS System Surveyor 4000 SE Trimble; •CSI MBX-2 Radio Beacon Receiver; •MTS 160 radio link; •RTK OTF Site Surveyor 4400 Trimble; •NIKON 310 DTM, Sokkia SET 600 Total Stations; •TRACKPOINT II underwater navigation system; Navigation software; •Integrated navigation system HYDRO, with helmsman's display and plotter.

Hydroacoustics equipment

•DESO 15 echosounder (33, 210 KHz); •SEABAT 9001 multibeam echosounder; •DF-1000 EdgeTech sidescan sonar; •EG&G UNIBOOM boomer; •ORETECH 3010-S subbottom profiler; •SHD-700SS WESMAR sidescan sonar; •X-STAR subbottom profiler (chirp technology); Additional equipment; •TSS 333/B motion sensor; •DMS-05 motion sensor; •PLATH gyrocompass; •MICRO CTD-3 probe; •VKG-3 vibrocorer; •Kullenberg gravity corer; •SEAEYE 600 DT ROV - TV inspection; •NORTEK – acoustic Doppler current profiler; •High-accuracy nuclear silt density probe; •SeaSpy – gradiometer.

Data acquisition and processing

•EPC 1086 grey scale printer; •CODA DA 200 digital data acquisition system; •Hewlett-Packard 9000/J 282 workstation; •CODA DA 50 digital data acquisition system; •GIS ArcInfo, ArcView; •HP 755 CM Plotter •Contex A0 full colour scanner.

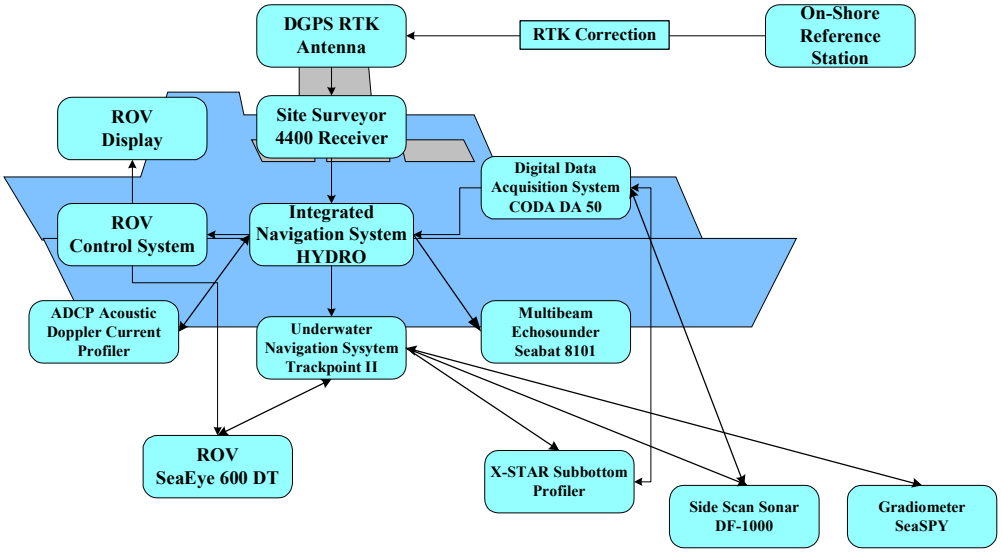

Figure 1: Integrated navigation system for marine measurements, implemented in the Maritime Institute in Gdańsk.

Els Verfaillie: Geostatistics as a tool for predictive modelling of the Belgian continental shelf .

For the **mapping of soft substrata**, the **sedimentology** (e.g., grain size, silt-clay %) is an important factor to explain the occurrence of **macrobenthos**. Generally, there is a large amount of sedimentological samples, while its interpolation can be difficult over complex seafloors. The amount of macrobenthic samples is generally small.

The aim of this study is to obtain a full coverage map of the **physical habitat**, starting with the median grain size. Moreover, an estimation of the error of the result of predictive modelling is another aim. The output of this model will serve as an input for other models (a.o., Marbiol_Ugent model) to obtain a full coverage map of the **biological habitat**.

The methodology consists out of four steps:

1) **Large-scale zonation and cleaning of data**: Delineation of large morphological entities based on bathymetry (digital elevation model or DEM), slopes.

2) **Geostatistics = kriging techniques**: Those techniques allow taking advantage of the **spatial correlation** between neighbouring observations to predict values at unsampled locations. Multivariate geostatistics use secondary information such as a full coverage digital terrain model, which assists in the interpolation. When there is a correlation between the primary (grain size) and secondary variable (bathymetry), it is possible to produce a more accurate prediction of the first variable. The use of the bathymetry as secondary information is very valuable because it is available as **full coverage** information (DEM) and it is cheaper to obtain than samples.

3) **Modelling of the relationship between macrobenthos and physical data**: biological models, using a relationship between the sedimentology and biological species and communities are produced by the Marine Biology Section of the Ghent University.

4) **Refinement of zonation**: Delineation of top, flank, swale, foot of sandbanks based on full coverage maps of sedimentology, surficial geology, hydrodynamics, sediment transport. The small scale zones serve as entities for: biological valuation, anthropogenic impacts and control units for the relationships between physical data and macrobenthos.

Two results of geostatistics are compared: ordinary kriging with the use of an anisotropic variogram and kriging with external drift. The second technique is a multivariate technique which calculates a trend between the first (grain size) and second variable (bathymetry) in each interpolation window. It is very useful, because the secondary information is available as full coverage information and because there is a correlation between both variables of 0.46. The results are two maps of the median grain size on the Belgian continental shelf. Using cross validation and jack knifing as validation techniques, validation indices were produced, from which MSEE (mean square estimation error) is the most important. The jack knifing MSEE index shows that kriging with external drift has a result which is 15.7% better than the result of ordinary kriging.

The relevance of this model is that the sedimentology is crucial for mapping macrobenthos in soft substrates (e.g., Wu *et al.*, 1997; Leecaster, 2003; Van Hoey *et al.*, 2004). The most important parameters are the median grain size and the silt-clay percentage. Furthermore, the output of the physical models serves as an input for biological models. The map of the median grain size will be used as an input for several biological models, which look for relationships between the grain size and species or communities. The result will be a full coverage map of the macrobenthos.

Future results are a full coverage map of the silt-clay percentage, the sedimentology using the Folk-Ward classification and other physical parameters relevant for biological models.

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Annex 12: Definitions for the terms habitat and marine landscape/seascape

The concept of "Habitat" for marine habitat mapping

The ICES Working Group on Marine Habitat Mapping advocates the following definition of "habitat" as used in the context of marine habitat classification and mapping:

Habitat: "A recognizable space which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular spatial and temporal scales."

This definition is not intended to alter the classical definition of habitat – which has long been defined as:

Habitat: "The locality in which a plant or animal naturally lives."

(Darwin, 1859)

Rather, the working group definition is intended to extend the classical definition to address ambiguities surrounding the term in the context of marine habitat mapping. Within the marine mapping context, three useful definitions that express the inclusion of varying degrees of biotic and abiotic elements are as follows:

Habitat: "An identifiable and distinct association of physical characteristics and associated biological assemblage used by an organism or community."

(Allee *et al.*, 2000):

The European Nature Information System (EUNIS) definition of habitat places even more emphasis on biotic communities, but continues to recognize the abiotic elements:

Habitat: "Plant and animal communities as the characterizing elements of the biotic environment, together with abiotic factors (soil, climate, water availability and quality, and others), operating together at a particular scale."

(EUNIS, 2002)

Also working with the relationship between biotic elements and the abiotic environment, other definitions of marine habitat place more emphasis on what can be readily mapped, with particular focus on the affiliation between physical elements and macrofaunal assemblages from benthic surveys. Kostylev *et al.* (2001) and Valentine *et al.* (2005) define habitat as:

Habitat: "Spatially recognizable areas where the physical, chemical, and biological environment is distinctly different from surrounding environments."

These types of variation in habitat definition with degrees of biological or species inclusion reflect the different objectives and applications of the data. The Allee et al. definition is tied to U.S. habitat mapping programs where essential fish habitats are a high priority. The EUNIS system has been extensively applied to near-shore habitat mapping in the United Kingdom and Ireland, where detailed species information has been gathered. The definitions proposed by Kostylev *et al.* (2001) and Valentine *et al.* (2005) have been used in studies of the Gulf of Maine, North America, in which several large tracts of multi-beam acoustic mapping have been completed.

An addition to the scientific considerations when using the term "habitat", there are also a variety of legal and administrative definitions of such terms. As one example:

"Natural habitats means terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or semi-natural"

EU Habitats Directive 92/43/EEC (Anonymous, 1992)

The definition of habitat advocated by the ICES WGMHM is built upon the following assumptions:

1) The classical ecological and biological definition of habitat as given above conveys the central intent and meaning of the term.

2) While dependencies exist between individual organisms and their environment, maps of physical environmental features without reference to past or current biotic presence are not habitat maps, but rather more appropriately described as physiotope maps, or maps of marine physiographic conditions. Geological maps of the seafloor are one example of this type of map.

3) From a practical standpoint, marine mapping based largely on physical characteristics of the environment are often good surrogates for habitat maps, however such maps are models based on assumed correlations that may require extensive validation work and biotic surveys before evolving into true habitat maps.

4) Mapped habitats, like all map features, are dependant on the spatial domain and grain employed. At coarse map grain, the thematic habitat descriptions will tend to be generalized. For example, a rocky intertidal habitat at one map scale can be mapped as a series of discrete habitats within tidal zones at finer spatial scales. In this sense, habitats can be hierarchical, though over very large areas, other terms such as "seascape" are more appropriate. Habitats defined solely by physiographic features allow the cartographer to map habitats at any spatial or temporal grain and domain. By including the organism or community, appropriate scales are clarified, and the value of the marine habitat map concept is enhanced.

5) Historic species range, ecoregion boundaries, as well as internal heterogeneity serve to define the habitat domain and limit the extent of physiographic extrapolations. For example, two seemingly identical habitats that occur in different ecoregions should be independently validated for species composition and ecological function.

Related terms: Landscape / Marine Landscape / Seascape

In general use and as a legal term in some countries, the term "seascape" is often used to describe a view or picture of the sea, *i.e.* at its surface. In the context of landscape ecology and marine habitat mapping, the above terms are more specific, and relate to seabed topography. They refer to an area of integrated landforms and biota in which a range of habitat types may occur. In this sense, the terms imply a spatial extent larger than habitats, and smaller than large marine ecosystems and marine ecoregions. Particular marine landscape types may comprise a suite of habitat types which occur together in a recognisable pattern, such as in an estuary or on a seamount. Appropriate spatial scales for habitats – and thus for landscapes are variable. As with the term "habitat", some authors focus on the physiographic and oceanographic elements of marine landscapes, excluding biotic structure.

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Annex 13: Draft Terms of Reference 2005

The Working Group on Marine Habitat Mapping [WGMHM] (Chair: D. Connor, UK) will meet in Galway, Ireland from 4–7 April [or possibly 25–28 April] 2006 to:

International programmes

a) Review progress of international mapping programmes (including MESH, EEA, OSPAR, BALANCE).

b) Assess and review existing habitat maps for the North Sea and make recommendations on how these maps may be further developed.

National programmes (National Status Reports)

c) Present and review national habitat mapping activity during the preceding year, providing National Status Report updates according to the standard reporting format. (Presentations limited to 10 minutes per country)

Mapping strategies and survey techniques

d) Refine the table of generic habitat mapping datasets, developed by WGMHM 2005, particularly to develop a generic specification of the information needed to produce habitat maps.

e) Initiate the compilation of a list of metadata catalogues which provide data suitable to support habitat mapping studies (*i.e.* linked to the table of generic datasets).

f) Review the report of the SGASC relating to acoustic seabed classification.

Protocols and standards for habitat mapping

g) Finalise the definitions of the terms habitat and marine landscape/seascape for the purposes of marine habitat mapping.

h) Review and critique guidelines for habitat mapping, including the review of protocols and standards for habitat mapping developed under relevant initiatives (e.g. MESH). In addition, identify other areas where the development of guidelines is required.

i) Review standards for calibrating acoustic survey systems.

j) Review progress in the development of 'discovery' and 'survey/method' metadata standards for marine habitat mapping, illustrated with worked examples.

Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions) and its relevance in understanding ecosystems

k) Review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications. Develop a link between various scales and types of maps to relevant issues and end user needs.

l) Explore the use of habitat maps in understanding and assessing ecosystem structure and function.

WGMHM will report by xx April 2006 for the attention of the Marine Habitat and the Fisheries Technology Committees, as well as ACE.

Supporting Information

Priority	This Group coordinates the review of habitat classification and mapping activities in the ICES area and promotes standardization of approaches and techniques to the extent possible.
Scientific justification and relation to Action Plan	Action Plan nos.: 1.4.1, 1.4.2, 1.4, 1.4.3. a) The WG provides an important forum to present and discuss the progress of multinational programmes, in particular those of NIVA for the EEA, within the Interreg MESH project for North West Europe, the OSPAR-wide programme and the proposed BALANCE project for the Baltic Sea. The strategies, standards and issues addressed by each programme need to be assessed to facilitate sharing of best practice, sharing of difficulties and to work towards integration of resultant maps if feasible. b) WGMHM has considered the production of habitat maps for the North Sea for several years, through the assessment of data requirements and consideration of various approaches to development of such broad-scale maps. Several mapping projects covering all or part of the North Sea (e.g. the EEA's EUNIS map, MarGIS and ongoing MESH work) will become available during 2005/6 and these should be assessed in the light of ongoing ICES needs for North Sea maps (e.g. by REGNS) and to consider whether WGMHM can provide data or expertise which will help further develop the maps. c) The compilation of National Status Reports is required to keep abreast of current activities and bring attention to new initiatives, developing techniques and data availability. d) A generic table of data requirements developed in 2005 needs further refinement to provide a guide to the types of data and their format which are necessary to map or model the distribution of marine habitats. e) A compilation of sources of suitable data for marine habitat mapping is considered a helpful adjunct to the generic table developed above. f) The SGASC report is due for release in 2005 and its relevance to WGMHM work needs to be assessed. g) Draft definitions for the terms Habitat and Marine landscape, developed during WGMHM 2005, need to be finalised. h) Review of standards for habitat mapping is of key importance to promoting best practice in mapping studies and in the interoperability of the data. Expertise with WGMHM should contribute to such best practice approaches. The development of standards and protocols within the MESH project provides a significant source of information for discussion, further development and the identification of any gaps. i) As part of the development of standards, an assessment of the needs for calibrating acoustic survey systems is required, again to promote best practice in use of this equipment. j) Sound data management is important in the archiving and distribution of data sets. There is a need to build upon the 2005 WGMHM work to clarify the relationship between data types, including through illustrated examples and to learn from data management approaches adopted in other sectors. k) Habitat maps can have many different purposes, styles and scales, dependent on end user needs. There is a need to compile guidance on the types of maps which are best suited for particular end uses and scales. l) The relevance of habitat mapping to other aspects of ecosystem structure and function needs to be examined, to reveal strengths and potential weaknesses and to highlight the relevance of habitat mapping to other sectors of research and environmental management, e.g. fisheries management.
Resource requirements	
Participants	Representatives from Member Countries with experience in habitat mapping and classification. Participation of the Baltic countries is particularly sought. The participation of members of BEWG, WGEXT, WGECO, WGDEC, WGFAST would be helpful in developing appropriate

	linkages to other areas of ICES work.
Secretariat facilities	
Financial:	
Linkage to Advisory Committee	ACE
Linkages to other Committees or groups	BEWG and SGNSBP, WGEXT, WGECO, WGDEC, WGFAST and SGASC, SGEH (Baltic Committee)
Linkages to other organizations	OSPAR, HELCOM, EEA
Secretariat Cost share	

Annex 13: Action Plan Progress Review

Year	Committee Acronym	Committee name	Expert Group	Reference to other committees	Expert Group report (ICES Code)	Resolution No.		
2004/2005	MHC	Marine Habitat	WGMHM		2005:\E:05	2.00E+05		
Action Plan	Action Required	ToR's	ToR	Satisfactory Progress	No Progress	Unsatisfatory Progress	Output (link to relevant report)	Comments (e.g., delays, problems, other types of progress, needs, etc.
No.	Text	Text	Ref. (a, b, c)	S	0	U	Report code and section	Text
International programmes (Baltic, MESH North-West Europe, North Sea)								
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Discuss and propose a strategy for implementing the development of a habitat classification framework and habitat maps for the Baltic Sea [HELCOM 2004]	a)	S			3.2	Now dependent of funding for projects (e.g. BALANCE)
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Develop a benthic/pelagic habitat map for the North Sea to EUNIS level 4 or similar, based on data sources compiled or made available to the Working Group and compiled into a GIS, and to assess future data requirements and issues arising from the process	b)			U	3.3	Requires significant resources; WG to work with other projects (e.g. EEA EUNIS) to take this forward
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Compare international habitat mapping methodologies, and work towards a best practice appro	c)	S			3.4	In progress
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Review progress of international mapping programmes (e.g., MESH, EEA, Baltic, ICES)	d)	S			3.1	
National programmes (National Status Reports)								
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Present and review National Status Reports on habitat mapping activity during the preceding year according to the standard reporting format (presentations limited to 10 minutes per country).	e)	S			4	
Mapping strategies and survey techniques								
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Review progress on intercalibration and quality control of mapping techniques. To construct a habitat mapping decision tree that can be applied to various management issues, identifying base requirements and evaluate the incremental values of mapping techniques (primer document to be circulated 3 months prior to meeting);	f)			U	6.1	Some progress on calibration, but decision tree work deferred
1.4.1, 1.4.2, 1.4, 1.4.3		To review the activities of the SGASC relating to acoustic seabed classification.	g)			U	6.2	No report available from SGASC

Protocols and standards for habitat mapping								
1.4.1, 1.4.2, 1.4, 1.4.3	**Please see AP items below**	Develop a working definition of the terms habitat and marine landscape/seascape for the purposes of mapping;	h)	S			5.1	
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Further progress the development of guidelines for habitat mapping, including the review of developments of protocols and standards for habitat mapping within the MESH project and other relevant initiatives (a report of the MESH project should be circulated prior to the meeting);	i)	S			5.2	In progress
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Report on progress in the development of metadata standards for marine habitat mapping.	j)	S			5.3	In progress
Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions)								
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications.	k)	S			7	In progress
Relevance of habitat mapping to other aspects of marine ecosystems (fisheries, pelagic)								
1.4.1, 1.4.2, 1.4, 1.4.3	Please see AP items below	Extract and compile habitat mapping data at EUNIS level 4 or above at the scale of the ICES rectangle across the North Sea area, and submit this data (in excel spreadsheet format) to the secure REGNS website in preparation of the REGNS Integrated Assessment Workshop in 2005. Also provide maps of sediment characteristics at the scale of the ICES rectangle across the North Sea area	l)			U	8.1	Beyond capability of WG this year; but EEA EUNIS map may fulfil needs for REGNS.

Action plan nos. to be crosslinked to tors	
1.40	Develop a comprehensive approach to habitat classification that will be the basis of a consistent application throughout the ICES Area. [MHC/FTC]. Building upon the work of the past three years, the challenges now include the following activities:
1.4.1	Test the validity of the proposed classification by producing habitat maps based on physical and biological field samples. [MHC/DFC]
1.4.2	Develop relationships between habitat characteristics and biological assemblages. [LRC/MHC/DFC]
1.4.3	Establish a framework to evaluate acoustic seabed classification technology and applications in bottom mapping. [FTC/MHC]